INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

JULY 1958
ONE DOLLAR FIFTY CENTS A COPY

World-Wide Oil Activities

in 125 countries and territories

European Refining Construction Booming

Drilling Rig Locator and Well Servicing Rigs

Pipeline Graphic Engineering Digest

Dowell develops a "missile" to measure INNER space

Recently, Dowell introduced a new tool to the oil industry. Called the Sonar Caliper, it is designed to measure the size and shape of cavities in brine wells and to determine the capacity of LPG storage reservoirs.

Now, with the record of many jobs behind it, Dowell can report the unqualified success of this new instrument in exploring and describing inner space.

Dowell's Sonar Caliper has many advantages over tools previously used: Surveys are fast, usually requiring less than six hours from start to finish; a photographic process provides a permanent record of each depth surveyed; a compass provides a constant directional reference; and accuracy is provided to ± 5%.

The illustration above shows the ultrasonic measuring device and plastic scale models like those provided with all Sonar Caliper surveys. These models show the vertical relationship of horizontal cross-sections in the wells surveyed. Together with the other records of the survey, the scale model becomes a permanent part of the picture of the underground cavity.

The Sonar Caliper, the new "missile" to measure Inner Space, is one more evidence of Dowell's continuing leadership in the science and technology of the oil industry. For more information or service, call the nearest Dowell office. Or write Dowell, Tulsa 1, Oklahoma.

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A Magazine of Petroleum Management

the Petroleum Engineer

FOR MANAGEMENT

NUMBER 7 • VOLUME XXX • JULY, 1958

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Money is like an arm or a leg — use it or lose it . . .

— *Henry Ford*

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There's a struggle going on across the Communist border line for control of petroleum resources. The Soviet made some gains in 1957, their first substantial victories in the scramble for the world's most useful energy. The Free World made greater progress . . . oil companies found oil, built refineries and pipelines, and supplied a record demand. — *Ernestine Adams*

Countries and territories covered are:

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The New Immigration

Give us your capital, your science,
Your know-how that touches even simple things,
Send these — the experienced veterans, the smiling young technicians
To find for us the golden power beneath the land
That we, too, may throw off enslaving drudgery and, at last, lift our heads
To hope!

WHEN THE U. S. was young it was built by the "huddled masses, yearning to be free" who came "from the teaming shores" of the old world.

Today scores of small countries call to us for a new kind of immigrant — not the poor but the rich — not the tired but the strong. They need the learned, the experienced, the proficient — to help build their economies, to develop their resources, to point the way to better living.

The international oil industry — and this does not mean only the big international companies — does more than any one industry to carry capital and experience to the have-nots of the earth.

Sometimes, in the jungles of Peru or on the coast of Dhofar, comes the exciting discovery of oil. Sometimes you drill on another weary year and spend a few more millions because you think: "It has to be there."

After the discovery, you've barely begun. You must produce oil, transport it, process it, get it to market. Finding a market may be harder than finding oil but every small corner of the earth is carefully combed for customers. Tankers edge along an island coast line in almost door-to-door selling. In a caravan pushing across a desert the clang of kerosine cans joins the clatter of camel bells. Oil products are everywhere — the magical energy of the century.

The GREATEST hazard of the petroleum industry is politics. When operations are successful there are always some to say (in the United States and everywhere): "Give us your capital and your experience and we will keep them and throw you out." But it is not so easy to do. You cannot cage capital and experience. Investment must be renewed again and again. Our experience in petroleum operations is an heritage of 100 years of development work and technical progress.

The appeal of the have-nots overcomes the risk — oil operators are a risk-taking lot, anyway. They seek oil in strange, forbidding climates . . . they carry it by truck and tanker and pipes over mountains and sea to towers where science transforms it into useful products. They give the people of the world the means of comfort and of strength.

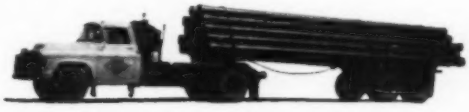
They answer the plea of calls from afar —"Give us your capital — your know-how."

Ernestine Adams

Congrats and $25 to WM. L. CAIN, Production Dept., Phillips Petroleum Co., Bartlesville, Okla.

Lone Star Steel, Joe Roughneck's solid source of supply for casing, tubing and line pipe, has completed an important part of its multi-million dollar expansion program . . a new stretch-reducing mill. This ultra-modern new facility makes API quality 2⅜" and 2⅞" tubing and 4½" casing.

Many noted oil authorities have predicted great things for the industry in the coming months . . and Lone Star is prepared to deliver pipe on the double . . whenever and wherever Joe needs it.



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THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS—THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS

Another Gas-Gathering System relies upon

"Oilwell" Direct-Connected Compressor Units

In this application, cooling fans are positioned outside the building. Updraft action eliminated consideration of prevailing wind problems.

This photo was made before the building was erected . . . showing how simple the installation details can be with "Oilwell" DGE Compressor Units.

Near Graham, Texas, Universoil, Inc. is gathering gas at field pressures of approximately 20 psi and discharging it into transmission lines at 800 psi with "Oilwell" DGE-300 two-stage compressor units. In this installation, each of the three units has a capacity of approximately 1,275,000 cu. ft. per day at compressor speeds of 300 rpm.

These duplex units consist of two slow-speed, horizontal-type compressors with top suction and bottom discharge connections. They are mounted side by side and are driven through right-angle, spiral-bevel gears by a single prime mover—all on a common skid base.

Each unit has its own heavy-duty, horizontal, updraft radiator with divided core for separately cooling the engine and compressor. For 250 and 300 hp sizes, the radiator and fan assembly is mounted adjacent to the engine and driven from the crankshaft by means of a torque tube and fluid coupling.

An "Oilwell" Engineer will be glad to help you select the compressor that is best suited for your next application. Our various units, ranging in size from 20 up to 300 hp, provide a wide choice.

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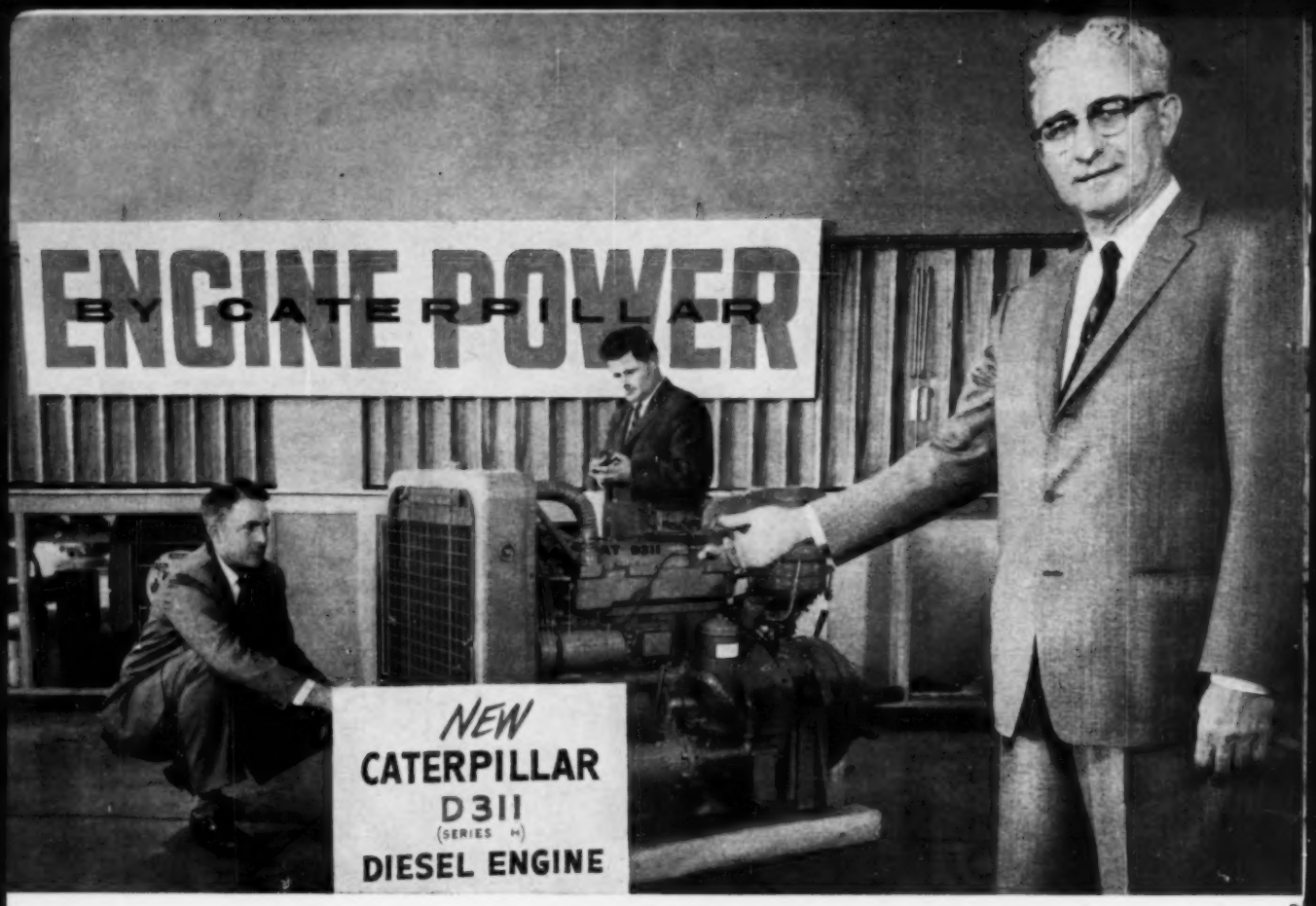
Oil Well Supply Division of USS TRADEMARK United States Steel



Here's a field-trained Caterpillar Engine Specialist to tell you why the all-new Cat D311 Diesel Engine is a *natural* for oilfield operations.

"HERE IT IS...THE NEW 75 HP* D311 (Series H) FOR OILFIELD USE!"

"Let's start right off with the *biggest* news about this new engine as far as you oilmen are concerned: BIGGER POWER IN A SMALLER PACKAGE! That's right, the all-new D311 (Series H) is smaller, lighter, but *more* powerful than its predecessor. And that's why it's *right* for you—a modern, heavy-duty engine that's easy to install, quick to put to work, easy to move and especially designed by Caterpillar to outlast and outwork any comparable unit in the oilfield.

"Now here are some of the jobs this mighty-mite D311 will do for you. It'll provide prime power for mud mixing pumps and water pumps; it's great for powering utility boats; it'll furnish continuous auxiliary power for lighting and other electrical facilities; and it'll drill for you, too, depending upon your power requirements. Whatever you put it to, this power-packed D311 will do a real job. And remember, the new D311 (Series H), like all Cat Engines, offers an exclusive trouble-free fuel system which enables the engine to hit peak performance even with low-cost fuels for economy of operation.

"There's more to the story of what the all-new Cat D311 (Series H) can do for your operation. For further information, including model pictures of the engine itself, use the coupon on opposite page. By the way, next time you visit your Cat Dealership, ask for the Cat Engine Specialist. Our field experience with *all* kinds of power application may prove profitable to you. We'll be glad to help—why not give us a call?"

CATERPILLAR DEALER dES ENGINE SPECIALIST

Engine Division, Caterpillar Tractor Co., Peoria, Ill., U. S. A.

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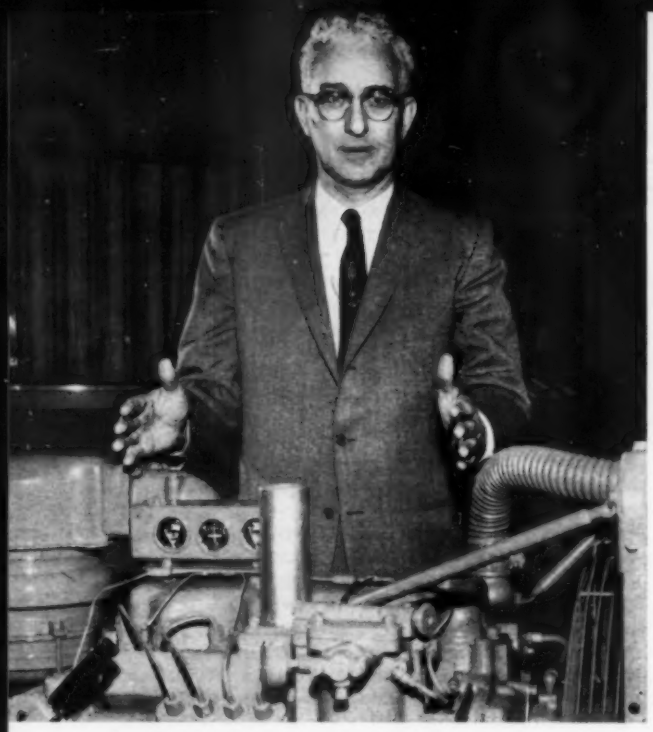
*Maximum output capacity



"Here's a demonstration of that *bigger power in a smaller package* feature I was telling you about. Though it's a full 9" shorter and 350 lb. lighter than its predecessor, the new D311 (Series H) packs *more* power . . . 75 HP (maximum output capacity). And I know that portable power like this is a *natural* for you oilmen."

"Now here's the dope on that utility boat power application I mentioned. This is a Caterpillar Propeller Calculator, and I'm selecting the correct propeller size for various types of boats. Our estimates tell us that the compact, latest-design D311 packs the necessary power to drive the 'big' wheel in utility boat application."

"This is a cutaway view of the latest-design Cat Generator. Like the new D311, this new 30 KW generator takes up less space, yet gives out *more* power. Matched to the heavy-duty equipment used in the oilfields, it offers the best features of self-regulated and externally regulated generators."

"Our Dealer Engineer and I are checking the specifications of the new D311. We're designing this modern, heavy-duty engine into equipment manufacturers' machines either as original power or for repowering. Cat engines are available in over 150 leading equipment manufacturers' machines."

D311 (Series H) Specifications

Horsepower	75 HP* @2400 RPM
Cylinders	4
Bore and Stroke	4" x 5"
Length (fan to flywheel)	36¼"
Width	27⅞"
Height	38¼"
Weight (net dry)	1180 lb.

Dept. PE7, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Illinois, U. S. A.

Send me more information about the completely new Cat D311 (Series H) Diesel Engine, Electric Set and Marine Engine.

- ☐ Have Caterpillar Engine Specialist call for an appointment as I may be in the market for this new engine or other Cat Engines up to 650 HP*.
- ☐ Send me more information, including model pictures, on this new engine.

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

THE CONFERENCE TABLE

Money is like an arm or a leg — use it or lose it . . . . . . HENRY FORD

Why Not Counter Sue?

When we owned a small newspaper we were always in the thick of political squabbles. Just before one election we had a suit of $50,000 filed against us because of an ad we'd carried for one candidate against another.

The $50,000 suit hit the pages of all the district's newspapers. It was in the 30's and we viewed the headlines right proudly. Being sued for $50,000 sounded mighty prosperous.

As soon as the election was over, the suit was dropped and forgotten. It was all in good, not-too-clean political fun.

The "Mother Hubbard" suit kinda reminded us of old times and this new one against 29 companies is another memory awakener.

The difference between the suit against us and this latest Justice Department move is that our fun didn't cost anything — in money or public opinion. Old Bob tho't the suit would help him but it didn't. He got beat just the same.

But the indictments against the petroleum companies is costly in public opinion and in money. It is so costly we don't see why some of the companies don't get permission to sue the government for false accusation. You can't be in jeopardy time after time for the same baseless indictments. Or can you? We wouldn't mind if it were just election games, but it's getting deadly serious. Will one of you companies please file a counter suit against Uncle Sam?

It is common to see good intentions, if they are carried out without moderation, push man into very vicious results ... Montaigne

Books of Diverse Opinion

We're receiving a number of authoritative books — all proving different things.

One author says the American consumer stands to benefit directly from a moderately rising level of oil imports, which will counterbalance the drilling costs of domestic oil production. The book, by John H. Lichtblau, is published by the Petroleum Industry Research Foundation, Inc., 122 E. 42nd Street, New York 17, New York. The author is the director of research.

The title "United States Oil Imports" is described as "A case study in international trade." The book makes the most of arguments for oil imports and has no criticism of them. It is more a plea than a study. One of its points: "imported oil also has significance in relation to America's national security, since it provides 6 percent of our total energy needs, helps to conserve domestic oil reserves, and makes defense expenditures more bearable by acting as a deterrent to increases in energy costs" will hardly appeal at this time to a Texas oil producer with his strict allowable and large margin of production potential.

On exactly the opposite side of the fence is "The Future Supply of Oil and Gas," by Bruce C. Netschert, a research associate in the Energy and Minerals Area of Resources for the Future, Inc. From 1951 to 1955 he was on the staff of the President's Materials Policy Commission and a consultant in the Materials Area to the National Security Resources Board and the office of defense mobilization.

In this report technology is considered a dynamic factor of great importance in its impact on future oil and gas availability and he believes that the United States has a potentially ample oil and gas supply — at least through 1975. He concludes that the United States and the Continental Shelf contain some 500 billion bbl of oil and 1.2 quadrillion cu ft of natural gas. He does not feel that conservation at this time is necessary nor does he feel that the United States needs to develop atomic power at this time to keep domestic energy costs from rising.

This volume, published by John Hopkins Press, costs $3. There is no price on the "United States Oil Imports" book.

Doubtless we haven't heard the last on the subject of imports. It began when Gulf Oil published "The Shift of World Petroleum Power Away From the United States," a study by Leonard M. Fanning, editor of "World Petroleum Policies." This follows the familiar pattern that E. DeGolyer set many years ago when he first visited the Middle East — that the center of gravity for oil is the Middle East. If we could clear away the underbrush of politics with its increasing nationalistic tendencies and tug-of-war between Capitalism and Communism; that is, if we could have oil operations in a vacuum we could easily go along with Mr. Fanning's implied advice to "Go East Young Oil Man — Go East."

The most telling argument for imports is the fact that so many smaller integrated companies and independents are searching over the face of the globe for oil outside the United States. High costs, strict allowables, and the lure of the other side of the road, is attracting a swarm of new operators into foreign fields, and with them go the service companies, the drilling contractors, supply and equipment houses. Young oil men are going east, west, north and south. (See Page A-17 for world-wide survey.)

Technical Article Checklist

Look at the trade journal article as a special type of writing that it is, and make the following organization and presentation checks:

1. **First consider the article as a whole**
   a. Have you told a story?
   b. Do you think the reader will feel he has gained something?
   c. Have you told your story as briefly as you know how?
2. **Consider the article from your viewpoint**
   a. What are you trying to tell in the article?
   b. Have you "put over" what you have in mind?
3. **Consider the article from the reader's viewpoint**
   a. Will most of your readers understand your article?
   b. Will most of your readers feel that they did not waste their time in reading your article?
4. **Consider the organization of the article**
   a. Have you made a concise summary opening that "places" your story and entices reader to continue?
   b. Have you given enough background in the "flashback" to permit non-specialists to know what you are talking about?
   c. Have you summarized your points and given the reader "something to take home?"

Check the above questions with your article and then make the usual composition and grammar checks.

New Key to European Oil

Anyone interested in world oil operations will find "The Search For and Exploitation of Crude Oil and Natural Gas in the OEEC Area" an essential reference book. Information was collected and the book was published by the Organization for European Economic Co-Operation in Paris. The volume is $10 and is available at OEEC Publications Office, 1346 Connecticut Avenue, N. W., Washington 6, D. C.

The OEEC area includes the 17-member countries of the OEEC group together with Spain and Yugoslavia. The study covers mining laws and fiscal regulations of each country, the geology of producing and non-producing countries, and shows a surprisingly large expanse of prospective territory in the geological map which comes separately. Also in the detailed review are exploration and production activities, mostly since 1944. There are excellent graphs of production by country showing prospects of a steady increase in the next few years, as there has been since 1944.

One thing we will compliment the publication on is that it is almost up to date.

Brainstorming is simply imagination brought to the surface.

Keep Costs Competitive

American workmen today are pricing themselves out of the market in the face of rising competition from foreign countries, Chairman (of U. S. Steel) Blough said in addressing the Cleveland Chamber of Commerce recently.

Asserting that tariffs and other such expedients offer no permanent solution, Mr. Blough said that "the only practical way to keep foreign-made products from over-crowding our markets here at home is to compete on equal terms in quality, in price and in service; and that the only practical way to reach foreign markets successfully is to keep our costs — which means primarily our wage costs — competitive."

"And right here," he added, "is where I think that the American workman is being mislead in a big way by some of his most vocal and powerful leaders.... To me, then, the perpetrators of this hoax are labor's one-way philanthropists. They would take jobs away from our workmen and give them to workmen abroad! And that kind of labor philanthropy is my idea of economic crime on the waterfront!" America must face squarely to the "undeniable fact" that, as a nation, it is costing itself out of the market, Mr. Blough said.

"Raising the standard of living for everyone in this country, by producing more of the goods which everyone needs and wants is one thing, but raising the cost of producing those goods, so that the producer and his employees are placed at a competitive disadvantage, is quite another thing," he declared. "And when those who profess to speak in the interests of the American working man advocate rising wage costs as a means of increasing consumer purchasing power, they are seeking to perpetrate what is, in my opinion, the most dangerous hoax of our times.

"They know that higher wage costs can only be met by higher prices, so that in the end no increase in purchasing power results. Meanwhile, the ability of American workmen to compete with their industrious counterparts abroad is further diminished, thus shrinking the market for American products and diminishing the number of available American jobs."

After warning that Americans are going to have to compete with foreign enterprise or resign themselves to the fact that this nation will soon be on its way to losing industrial leadership, Mr. Blough said:

"Yet if we are to be competitive — and remain competitive — we have today the greatest opportunity, and the greatest potential market for the products of our people, that we have ever had in our history. With European production and standards of living rising at a rapid rate, millions of Western Europeans are eager to buy for themselves and their families all the luxuries of life that have become so commonplace to our people in America."

Mr. Blough said that "we as businessmen must do everything in our power to maintain our technological advantage over foreign producers by replacing as rapidly as we can every obsolete and obsolescent machine, technique and faculty we have, with new, better and more efficient methods and facilities."

He urged that Government re-examine "antiquated and misbegotten" tax laws that discourage investment and penalize production use of wealth.

"But despite all that we and Government may do to promote our competitive position, the final decision rests with the American working man and with his delegated leaders," Mr. Blough declared. "For the fact remains that in the last analysis the only one who can fully protect the American workman is the American workman himself. If he can keep wage costs from mounting while rising productivity brings our total costs into competitive balance with foreign costs, then truly I believe that he can expect to see the greatest era of prosperity our nation has ever known."

From The U. S. Steel Quarterly, May 1958

B of M Lists Publications

A new "Selected List of Bureau of Mines Publications on Petroleum, Natural Gas, and Helium" is now available from the Petroleum Experiment Station, Bartlesville, Oklahoma, or from other Bureau of Mines stations. This is the first list issued in five years. Present reference of 134 pages is the result of a new format devised by V. Vern Hutchison, librarian of the station.

As the title suggests, the emphasis has been on selectivity instead of complete coverage. The compiled material is now arranged under several broad subject divisions, such as Drilling and Completion, Production, Storage and Transportation, Chemistry and Refining, etc.

Persons doing research in petroleum subjects will find the selected list helpful in their work.

Equipment Manual Coming

In the next issue... on July 15... our engineering staff will bring you a comprehensive reference manual containing the most significant developments in the past year in new equipment, services, and products. That is the reason the equipment and trade literature departments are omitted this issue.

Manufacturers and service companies across the nation were asked to provide material describing their "best of the year." This reference issue is an editorial service... manufacturers and service companies pay nothing to list their most significant developments. Theme of the entire issue... from cover to cover... is on "the newest," and you can expect a host of the very best in every phase of petroleum equipment, services, and products.

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

Sale of Hancock 'Pending'

Fire-ravished Hancock Oil Company indicates that negotiations with an unnamed Eastern Oil company are continuing. Officials of Hancock suggest that "the right price" has not yet come along. Rumors are that Standard of New Jersey is the interested firm. Hancock's Signal Hill, California refinery was ripped by an $8,000,000 fire late in May, damaging a large part of a tank farm on its 40-acre property and heavily damaging refinery facilities.

LAV Has New Flight

Linea Aeropostal Venezolana inaugurated a direct six-hour flight between Maracaibo and New Orleans by bringing Venezuela press representatives to New Orleans and inviting Southwestern oil editors to join them on the return flight. The airline, one of South America's oldest and largest, offers three weekly flights both north and southbound departures on Tuesday, Thursday and Saturday. LAV's service is particularly designed for oil people.

Texaco Seaboard Inc. Formed

Stockholders of Seaboard Oil Company, Dallas, Texas, have approved reorganization and a transferral of all assets to a new Texas Company subsidiary, Texaco Seaboard Inc. Some 3,660,000 shares of capital stock of The Texas Company went to Seaboard stockholders in dissolution agreement on a share-for-share basis.

Midstates Purchase Asked

Tennessee Gas Transmission Company has filed with the SEC plans to purchase all outstanding shares of Middle States Petroleum Corporation. Stock offering will be on basis of 45 shares of TGT stock for each 100 of Middle States. The firm, through a subsidiary, Midstates Oil Company of Tulsa, Oklahoma, owns 496 net producing wells in Texas, Louisiana, Oklahoma, Mississippi, New Mexico, Arkansas, and Saskatchewan and has 308,954 net undeveloped acres under lease.

Imports Curb Widened

President Eisenhower has ordered that unfinished gasoline and unfinished oils be brought under the voluntary import control program. The new order restricts imports to currently prevailing levels, and officials say the rule will apply to average daily importation during the first five months of this year. A commentary report by Sec'y of Commerce Weeks stated the ruling was an effort to block circumvention of presently established quotas. The report stated that the government continues to prefer the voluntary system in preference to mandatory controls as desired by domestic producers, and indicated that a current need did not exist for import restrictions on residual fuel oil, asphalt distillate fuel or other oil products.

Price Fixing Denied

Justice Department officials as well as those of 29 oil companies admitted complete surprise at the federal grand jury indictment for crude oil and gasoline price fixing. The indictment delivered by a Justice Department-organized grand jury at Alexandria, Virginia, named the 29 for conspiracy to violate the Sherman Anti-Trust law. The grand jury had been in session for several months and had delivered no indictments prior to its closing action. Oil companies termed the vaguely-worded six-page instrument as "ridiculous, false, unjustified, untruthful, preposterous, astounding, and a shotgun indictment."

Murphy Integrates

Murphy Corporation of El Dorado, Arkansas, primarily a producer of crude and marketer of refined products, is seeking to close the "missing link" by purchase of outstanding common stock of Superior Refinery Owners, Inc. and Lake Superior Refining Company. Offer is conditional on acceptance by holders of 95 percent of common shares and 95 percent aggregate principal amount of notes of the two companies. The two firms were organized in 1950 to utilize crude from Alberta and to serve a trade area in Minnesota and Wisconsin.

In 1975: 16,440,000 B/D

Total domestic availability of crude oil in the U. S. in 1975 will be on the order of 6 billion bbl annually, predicts "The Future Supply of Oil and Gas," a new book written under a Ford Foundation grant. The book estimates that the availability of this much crude would be equivalent to an average supply of 16,440,000 bbl daily compared with an estimated total domestic requirement of 13,000,000 bbl daily. Increased reserves, the book contends, will be an effect of improved oil-finding technology combined with technological advances in recovery.

Gasoline Consumption Up

Peak consumption for motor vehicle gasoline is in July, reports of a recent API study indicates. Consumption may be expected to exceed last year's auto gasoline use of 5.4 billion gal in July. Total consumption of auto gasoline last year amounted to 57,402 million gal, API reports. California was No. 1 state consumer, using almost 5.5 billion gal; Texas, New York, Ohio and Pennsylvania, followed in that order.

99 Wilmington Wells Sold

Producing Properties, Inc., Dallas, Texas, made their first entry into West Coast production with the purchase of 99 Wilmington field oil wells at Long Beach, California. Producing Properties purchased the wells for $10,000,000 cash and other considerations from Continental Production Company and its principal stockholder, E. C. Simmons. Sale involves production of 2500 bbl daily under a partial waterflood expected to reach a peak of 10,000 bbl per day. New owners will attempt to increase bottomhole pressure of the leases.

Louisiana Gas Tax Tripled

Louisiana legislature has been successful in tripling the natural gas gathering tax in the state. The increased tax would go to the state school fund. Gas industry spokesmen say they cannot afford it, it will cause a serious handicap to present producers, extend the current recession, divert new industry planning to come into the state and destroy existing casinghead gas production companies. Louisiana teachers, who supported the new legislation, expected to lose as much as $990 per year individually through salary cuts.

Ruling Brings TIPRO Ire

If the Federal Power Commission is to exercise control over natural gas production at the wellhead, then it is obligated to concern itself with the welfare of producers and royalty owners, four producer groups stated in a joint brief filed with the FPC. The grievance was in opposition to recent Supreme Court decisions knocking down state minimum price laws, which TIPRO and others claim "patently unfair, unreasonable and unauthorized by the Natural Gas Act." FPC proposed regulations that would disallow rate increases previously made on the basis of state minimum price laws set up as conservation measures. Supreme Court ruled ineffective Kansas and Oklahoma minimum price laws in January.

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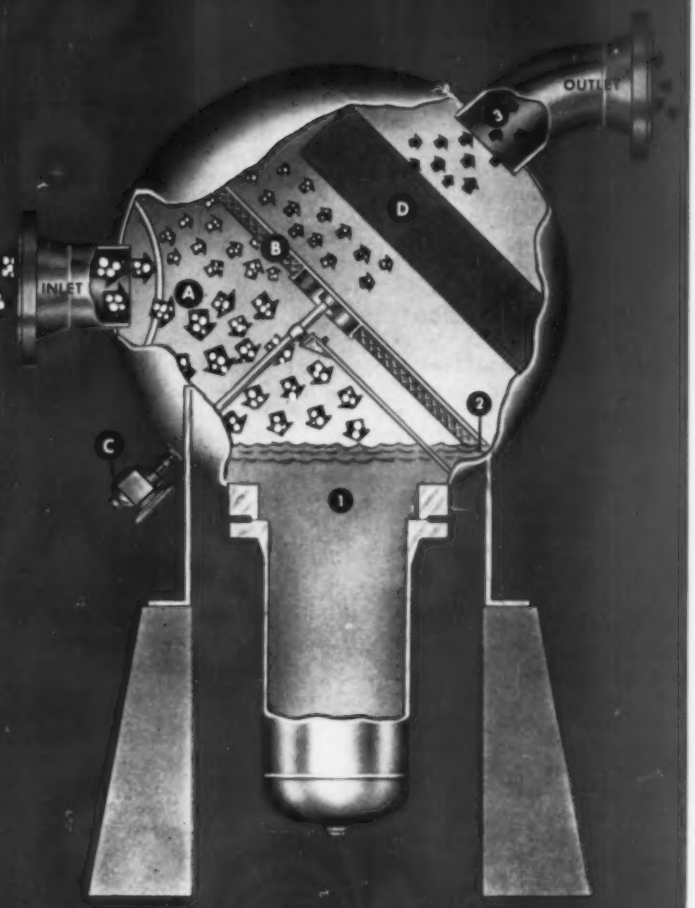
DUST and LIQUID SCRUBBER
FOR GAS PIPELINES



LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

- The **dust removal ability** of the SCRUBOSPHERE **is superior** because it utilizes wetted surfaces for dust collection which are much more closely spaced than in conventional equipment.
- **Oil loss is minimized** because the oil used to wet the dust collecting surface is lifted mechanically instead of bubbling gas through the oil which results in foaming and loss due to creation of hard-to-separate fine particles.
- **Maximum performance and low cost** — The spherical design means high capacity and performance because it provides maximum dimensions for the contactor and mist extractor which normally are limiting factors in scrubber designs. The vessel cost is reduced because required vessel thickness is only one half that required for cylindrical vessel of same diameter.
- **Versatility** — separates solid and liquid particles with equal efficiency.
- **Low pressure drop** — ½ to ¾ psi at rated capacity depending on nozzle size.

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Write for test data showing dust removal and oil loss of Peerless Scrubosphere as against conventional dust scrubber.

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HIGHLIGHTS—2 Digest of News and Comments

Refiners Hike Prices

Increased summer demand and lower inventories have affected gasoline prices in the Midcontinent region. D-X Sunray and Champlin Oil & Refining initiated a half-cent gasoline price increase that has been followed by most other refiners in the area. Affected were gasoline postings moving to northern markets as well as those in the Southwest. The hike is credited with helping restore equitable prices of gasoline at the retail level, as well as squelching price wars in both Texas and Oklahoma.

Dow Has New Division

Dowell Incorporated, a wholly-owned subsidiary of the Dow Chemical Company, is now a division of Dow. No changes in management will be made and general offices will remain in Tulsa, Oklahoma. Canadian operations are scheduled to be handled through a new Dow subsidiary and Dowell's Latin American subsidiary, United Oilwell Service, S. A., will also become a Dow subsidiary.

IPC Deal Closes

Jersey Standard announced that registration statement covering its offer to exchange nine shares of its stock for 10 shares of the stock of International Petroleum has become effective. The offer was made by means of a prospectus, mailed in May to registered shareholders of International. Jersey Standard accepted all International shares tendered for exchange before the offer terminated July 1.

BP Expands Research Lab

British Petroleum is one step nearer the end of its long-range research building program with the completion of its analytical and physics laboratory at the Sunbury Research Station (England). The new three-story, triangular building will house a technical staff of 300. Total cost of BP's current phase of its building program, which included erection of an exploration/production research lab is approximately $4,200,000.

API Names New Aide

Frank L. Dennis, a Washington newspaperman and lawyer, has been appointed to the executive staff of the American Petroleum Institute. He will be in the API's Washington office. Dennis, who will serve as special assistant to API President Frank Porter, was formerly director of the Press and Publication Service of the U. S. Information Service. He has held various posts: Executive editor on several newspapers, Director of Information for Europe of the Marshall Plan, Public Affairs Officer with rank of Counselor of Embassy in Rome, and chief of the policy division as Director of Public Relations of the USIA.

D and D Convention Set

A. C. Rubel, president, Union Oil of California, will be the principal speaker at the 7th annual convention of Association of Desk and Derrick Clubs of North America in Los Angeles, California, October 11, it was announced by Miss Maxine Hacke, Warren Petroleum, Tulsa, Oklahoma, president.

Miss Irma Cline, immediate past president, with Nelson, Montgomery, Robertson and Sellers, Wichita Falls, Texas, will give the keynote address.

Miss Hacke, and Miss Ellen Vaughan, Carter Oil, Shreveport, Louisiana, first vice president, are meeting in Los Angeles, June 14 and 15, with Mrs. Ann Hargrave, General Petroleum, and Miss Katherine Barnes, Schlumberger, chairman and co-chairman of the convention.

Pipeline Connections Asked

The Railroad Commission of Texas order requiring pipeline connections to producing wells has been met with applause from Texas Independent Producers and Royalty Owners Association. The ruling results from hearings of producers' complaints of failure to make proper well connections, which date back several months. Producers, who had at one time claimed that 40,000 unconnected wells existed in Texas, suggested that connection denials were a form of selective buying. Pipeline companies contended that many well connections would be economically impossible.

PEPA Leaders: Newly elected officers of the Petroleum Electric Power Association are: Vice president, D. S. Coffman, of Texas Power & Light Company, Dallas, Texas; president, Harvey Cherry, of Houston Lighting and Power, Houston, and secretary-treasurer, W. M. Larkin, of Gulf States Utilities Company, Beaumont. Officers were named at the 30th anniversary PEPA convention in Dallas.

Meetings

Aug. 14—API OIC Steering Committee, Waldorf-Astoria Hotel, New York City.
Aug. 18-21—ASME, Heat Transfer-AIChE conf., Northwestern University, Evanston, Ill.
Aug. 25-27—Appalachian Gas Measurement Short Course, University of West Virginia, Morgantown, W. Va.
Sept. 3-5—API Oil Information Committee, Hotel Statler, Boston, Mass.
Sept. 4-5—AIME, second international congress on air pollution, Statler Hotel, New York City.
Sept. 7-12—American Chemical Society, fall meeting, Chicago, Ill.
Sept. 9-12—10th National Chemical Exposition, Chicago section of the Amelcan Chemical Society, International Amphitheatre, Chicago, Ill.
Sept. 10-12—Mid-Continent Oil & Gas Assn., Mississippi-Alabama annual, Buena Vista Hotel, Biloxi, Miss.
Sept. 10-12—National Petroleum Association, 56th annual meeting, Traymore Hotel, Atlantic City, N. J.
Sept. 15-19—13th Annual Instrument-Automation Conf. & Exhibit, Philadelphia, Pa.
Sept. 18—NGAA, Rocky Mountain regional, Gladstone Hotel, Casper, Wyo.
Sept. 18-20—Rocky Mountain Assn. of Geologists, symposium of Pennsylvanian rocks, field trip to Paradox Basin, northwest and eastern Colorado.
Sept. 21-24—ASME, petroleum mechanical engineering conf., Cosmopolitan Hotel, Denver, Colo.
Sept. 21-24—American Institute of Chemical Engineers, regional meeting, Hotel Utah, Salt Lake City, U.
Sept. 22-28—ASTM, Statler Hotel, Boston, Mass.
Sept. 24-25—WPRA, Rocky Mountain regional technical-industrial relations meet, Henning Hotel, Casper, Wyo.
Sept. 25-26—Mid-Continent Oil & Gas Assn., Arkansas and Louisiana annual, Roosevelt Hotel, New Orleans, La.
Oct. 1-2—WPRA, 3rd annual stream pollution and waste disposal conf., Lassen Hotel, Wichita, Kans.
Oct. 1-3—AAODC, 18th annual, Adolphus and Baker hotels, Dallas, Tex.
Oct. 5-8—Society of Petroleum Engineers of AIME, fall meeting, Houston, Tex.
Oct. 7-8—Texas Mid-Continent Oil & Gas Assn., 39th annual, Statler Hilton Hotel, Dallas, Tex.
Oct. 9-10—ASME-AIME, conference on fuels, Chamberlain Hotel, Old Point Comfort, Va.
Oct. 9-10—California Natural Gasoline Association, 33rd annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
Oct. 12-18—OIL PROGRESS WEEK.
Oct. 13-15—AGA, 40th annual conf., Traymore Hotel, Atlantic City, N. J.
Oct. 13-15—ASME-ASLE, conference on lubrication, Statler Hotel, Los Angeles, Cal.
Oct. 13-16—Society of Exploration Geophysicists, annual meeting, Gunter Hotel, San Antonio, Tex.
Oct. 16-17—AIME, Southern California Petroleum Section, fall meeting, Biltmore Hotel, Los Angeles, Calif.
Oct. 16-19—Permain Basin Oil Show, Odessa, Tex.
Oct. 20-24—NACE, annual conf. & exhibition of South Central Region, Roosevelt Hotel, New Orleans, La.
Oct. 23-24—WPRA, El Dorado regional technical-industrial relations meet, Rufus Garrett Hotel, El Dorado, Ark.
Oct. 27-28—IPAA, annual meeting, Statler Hilton Hotel, Dallas, Tex.
Oct. 31—NGAA, Southern regional meeting, Carlton Hotel, Tyler, Tex.
Nov. 6-7—AAPG, Pacific section, annual meeting, Los Angeles.
Nov. 10-13—API 38th annual meet, Conrad Hilton Hotel & Palmer House, Chicago, Ill.

Good Wells Make Good News

A Monthly Report of Successful Well Treatments

July, 1958

For over-all fracturing economy—including first cost, time of payout, rate of decline, and frequency of workovers—it will pay you to consider Dowell's fracturing services. Here are some recent studies of Dowell fracturing results:

- **Beaver County, Oklahoma.** (New Gas Well) Completed through perforations into the Hoover formation, 4420 to 4467 feet, this well came in natural with a potential of 4190 mcfd. The well was broken down and treated with 500 gallons Mud Acid, followed by 500 gallons Dowell acid with demulsifying and silicate control agents added. This increased potential production to 6360 mcfd. Then the well was fractured with Petrojel*, using 30,000 gallons of gelled crude with 80,000 pounds of sand plus F.L.A.* (Fluid Loss Additive). The average injection rate was 54.2 bpm. After treatment and clean-up, the well was given a four point test which showed an *open flow potential of 126 mmcfd.*

- **Christian County, Illinois.** (New Oil Well) This well was completed open hole in the Silurian dolomite from 1910 feet to 1921 feet. Since this was known to be a problem reservoir, the operator had formation samples tested. He found that the formation reacted twice as fast with intensified acid as it did with regular acid. Accordingly, he ordered Acid Petrofrac* with Dowell's intensifying agent added. 7000 gallons of acid-oil emulsion and 7000 pounds of sand were used. Freflo* in oil and 500 gallons Dowell Silicate Control Acid preceded the Acid Petrofrac. *After the well returned the load oil, the sustained production was 15 boph.*

- **Hot Springs County, Wyoming.** (Old Oil Well) This well was completed open hole, 3495 to 3562 feet, in the Phosphoria lime. This dense formation has some natural fractures and minor effective vugs. Before treatment, production had declined to 8 bopd. Operator ordered Acid Petrofrac, using 5000 gallons acid-oil emulsion and 5000 pounds sand. F.L.A. was added to the fracturing fluid to help extend the fractures and the drainage area of the well. Treatment was performed down tubing at 9 bpm. *45 days after treatment well was producing 70 bpd with two per cent water.*

- **Harrison County, East Texas.** (Old Oil Well) This well, completed through perforations into the Travis Peak sand, 6272 to 6276 feet, had declined to 25 bopd. Operator wanted to stimulate potential so he could get full allowable for eight-day production. Petrojel was selected, using 5000 gallons gelled crude with 5000 pounds sand. Injection was down tubing at 8 bpm. *After treatment settled production was 273 bopd.*

You have an intimate knowledge of *your* production problems and *your* well's characteristics. Likewise, your Dowell engineer knows what each of the many Dowell fracturing services is designed to do. He will work closely with you to help you get the most from a stimulation treatment. For service call any of the 165 Dowell service points and offices. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

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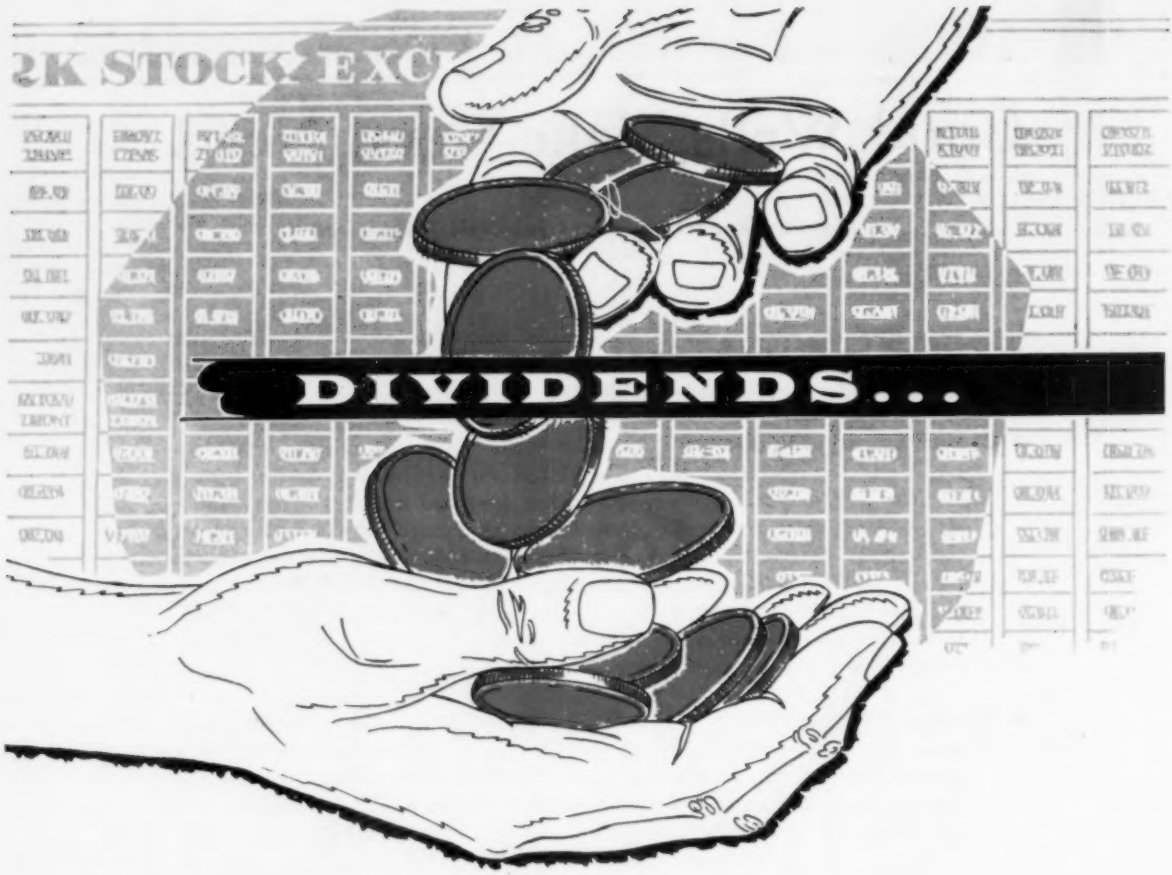

. . . that help you meet today's rising costs of doing business

Thousands of business and industrial firms in Texas are receiving substantial dividends without tying up needed operating funds in stocks, bonds or other securities. How?

They receive dividends as a result of having placed their workmen's compensation insurance with the Texas Employers' Insurance Association. Over five million dollars in dividends and discounts were distributed to policyholders of the Association in Texas last year . . . over $55,500,000 since organization.

You, too, may be able to join the thousands of Texas employers who receive these dividend payments. Investigate your opportunity to save . . . Now! Contact your nearest office or write direct to . . .

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Oil Companies Face USSR Competition

There's a struggle going on across the Communist border line for control of petroleum resources. The Soviet made some gains in 1957, their first substantial victories in the scramble for the world's most useful energy. The Free World made greater progress . . . oil companies found oil, built refineries and pipelines, and supplied a record demand

Ernestine Adams

POLITICAL POWERS of the Free World and Communism are face-to-face in a vital struggle for supremacy in atomic energy.

On another level—no less crucial—the Soviet and its allies are competing with Free World oil companies for the most useful energy in the world today.

Although not eminently successful in its program of development in their own petroleum-loaded land, the Communists maintain a constant pressure on the oil fronts of the world.

The first victories of early skirmishes showed up in strategic spots in 1957. After the Suez ruckus, Egypt turned to the Soviet for petroleum equipment and technology. Recently Soviet scientists and technicians came to Egypt to set up new oil research laboratories and to select a site for the new refinery Egypt obtained from the USSR. Egyptian experts are sent to Russia for training in petroleum engineering.

Syria made an agreement with the USSR to supply money and technical aid to develop its oil. Czechoslovakia is building a refinery at Homs, Syria.

Romania evidently has been awarded a contract to construct a refinery in India on long term credit. Soviet exploration crews are already in the country.

Ceylon's government asked the Soviet to send experts to prospect for oil in that Indian Ocean island.

When oil was discovered in Dhofar by Cities Service and Richfield, rebellion broke out on the borders and it was difficult to name the culprit. Who wanted the potentially oil-rich British protectorate?

In China Soviet help pushed oil production to a new high. Sakhalin and Manchuria and North Korea saw Communist crews in search of oil.

Along the front of the economic conflict Communists and oil companies were mixed. In Finland the USSR supplies 50% of the crude for Finland's new refinery, Shell supplies 40% and Gulf Oil, 10%.

In Syria MenHall Company, et al, controlled by a U.S. citizen of Syrian extraction, found the most promising field in the country. Yet Soviet experts were chosen to develop Syrian oil resources.

First ICA Guarantee

Our government is not entirely unaware of the competition for petroleum energy. For the first time the International Cooperative Administration guaranteed to protect U.S. investment abroad in oil operations. Edwin G. Pauley, whose company has been exploring Jordan, has an ICA guarantee against expropriation for a period of 20 years. Pauley-Jordan contract is on a 50-50 basis if oil is found.

When you know of the struggle goin on for petroleum energy around the periphery of Communist influence, you understand better why political and public relations of the industry are tense and uncertain.

Al-Kifah al-'Arabi, Beirut, Lebanese daily, recently quoted Senator Kefauver as saying that the Eisenhower Doctrine in the Middle East was designed to warn Arab states against any plans for nationalizing U.S. oil concessions and to pave the way for immediate intervention if nationalization took place.

This sounds like the Senator all right, but he probably didn't mean it to heat up the present Middle East temper. And really it is a mild example of the propaganda along the oil-producing front. Criticism has never been more reckless, more confident, more emphatically international.

In sharp contrast to the political and economic squeeze, at the operational level petroleum activities are pushing forward at a feverish pace. Never before have so many oil companies worked in so many countries. The world went right on to another record from exploration to consumption in 1957 despite closed canals, damaged pipelines, revolts in Eastern Europe, business slump in the USA.

In 125 nations and geographical divisions, oil companies had technicians on the job. Opposing the zealous Communist petroleum search were British, U.S., French, Dutch, Belgian, German, Canadian, Italian firms that rushed forth in what looked like a world oil boom.

Demand Rose 7%

World demand increased nearly 7% over 1956 after a 10% increase in that year over 1955. Expanded consumption triumphed over rationing, increased taxes on crude and products, and higher prices. Production and refining capacity rose about the same proportion. Refining capacity crossed the 20 million b/d line for the first time at the end of 1957.

Until the Suez closure, the U.S. industry had felt the effects of slowing demand; inventories had piled up. The sudden shortage caused by the Suez episode demanded a complete turnabout for operators in the Western Hemisphere — inventories were tapped and more production was needed. Some factions of the U.S. industry were reluctant to pull out all stops. They

Miss Adams is Management Editor.

feared what eventually happened — a glut of oil.

Probably never were the U.S. industry's public relations so low. Criticism was heaped on it and little credit was given for what turned out to be a superlative job.

Storage Laws Set

One result of the Suez crisis is a rash of new requirements for larger storage. France obliges refiners to stockpile three months' supplies in oil products; more in crude. Italy's law set 25% of annual crude oil capacity of its refineries in storage. Finland wants oil distributing companies to keep stocks to 25% or more of motor fuels; 15% for other products.

This is substantially more than the usual inventories in the U.S. The Suez situation emphasized Europe's dependence on Mideast oil, and the possibility of a sudden shutdown of supplies. It recalls proposals made in the U.S. for stockpiling petroleum products. Mostly these storage costs – increasingly high — are met by the companies. Some governments are studying the practicability of emergency stockpiles.

Outstanding highlight in concession contracts were several breaks in the 50-50 basis of agreement. A government-owned Japanese firm signed with Saudi Arabia and Kuwait for areas offshore of Kuwait-Saudi Arabia Neutral Zone. The contract apparently gives the countries 56% of any profit from production, transportation, refining and marketing of oil from the area. It will be many years before results of such an operation are evident. "Profits" have less practical definition than royalty and taxes.

Next came the Italian (ENI)-Iran pact, called a 75-25 deal. This is no bonus contract. If the Italian company finds oil it and the National Iranian Oil Company will share development expenses. Thus NIOC will own half the company. The government gets 50% of net returns and ENI and NIOC share the other 50%.

Exciting Developments

Spotlights fell on new areas of promise that attracted companies, large and small. Men and equipment poured into the Sahara from France, Great Britain, Holland and the USA.

Air-conditioned trailer camps rolled to location sites. A geophysical crew was said to cost $100,000 a month in the desert. Heat and sand and rebellion were thrown across the path of operations but nothing stopped the search for oil.

On the refining side Finland has its first one near Turku. State-owned, it fills half the present consumption. Ireland, too, will have its first oil refinery. Shell-Mex and BP, Caltex and Esso are building a 32,000 b/d plant at Whitegate Bay.

Refining expansion is almost a world wonder. Processors are pushing their skills and finding there are few limits.

Promising fields in Argentina are getting the pipelines needed to increase production. Three pipeline systems now contracted for or projected are expected to raise oil output from present fields to nearly 210,000 b/d by 1960; it is now 94,000 b/d.

Capital Needed

The growth in demand for capital outpaces petroleum demand. The petroleum industry — world-wide — is always in the red if you don't count the oil in the ground. Now greater costs demand more capital. Increasing costs come from inflation, from higher government costs, and from greater difficulties in operation (impossible operations become possible at a cost).

In 1956 oil investment accounted for about half the total capital invested by U.S. business abroad. U.S. Department of Commerce set this at $1395 million, which brought total investment in U.S. oil abroad to $7244 million. This does not include expenditures in oil operations not included as capital.

Don't you find it comforting that the Soviet government has assigned only $1 billion to petroleum expansion in 1958 and U.S. companies have budgeted $8 billion for the same expenditures here and abroad? The proportion for other Communist countries compared to the Free World outside the U.S. is possibly greater. Brazil, for instance, doubled its budget for petroleum — to $58 million.

The Brazil figure (as well as the Soviet) points out another fact — no government grants the capital necessary for oil development. Only the capital generated by oil profits and spent by those steeped in oil-industry know-how can hope to win the battle for petroleum resources.

ELEVENTH ANNUAL ROUND-UP OF WORLD OIL ACTIVITIES

EDITOR'S NOTES:
Figures are average for 1957 unless otherwise stated.
R.C. — Refining capacity
Runs — Crude runs to stills
(?) — Indicates information slight.

ADEN

R. C. 120,000 b/d
Runs 70,000 b/d

BP Refining (Aden), Ltd. has added a new 12,000 b/d thermal reforming unit to its refinery in the Aden Protectorate at the south edge of the Arabian Peninsula. Average throughput was down because of the closure of the Suez Canal in early 1957.

AFGHANISTAN

The second test of Angut is Sar-i-Pul, which was started in early March 1957, was suspended for four months due to some technical difficulties, and finally completed on March 29, 1958. Final drilling depth was 3675 ft. Further drilling seemed impossible due to technical difficulties. The result of drilling is hopeful. Drilling is done by Swedish and Afghan experts. Measures have been taken to drill the third well of Angut.

ALASKA

Alaska has been called America's last frontier, but we are always reluctant to put last in front of America's frontiers.

1957 saw the biggest spurt in oil activities. A boost was given by Richfield Oil's discovery on the Kenai Peninsula. The well is closed in awaiting markets. Five other wells were drilled. The discovery was made on a 72,000-acre unitized area in which Richfield has 89% interest, the remainder being held by Union Oil of California and Ohio Oil.

The find increased the rush for leases and now some 8 to 10 million acres are under lease by U. S. oil companies.

Phillips Petroleum was the first major company to go in. It began moving in equipment in 1953 on its million acre lease in the Katalla-Yakataga area. Heavy exploration by a number of companies is going ahead full force. Among those with large holdings are Colorado Oil and Gas, Standard of California, Sunray Mid-Continent, H. L. Hunt interests, etc.

Alaska-Yukon Refining and Distribution, Ltd., is building a 7500 b/d plant at Haines for an estimated cost of $6 million.

ALBANIA

Prod. 7000 b/d? **R. C. 7000 b/d?**
Runs 6500 b/d?

These estimates are giving Albania full credit for its determination to increase production and its refining capacity. Present five-year plan calls for 10,000 b/d production in 1960.

Demand is estimated at around 4000 b/d, so some exports are available.

ALGERIA

Prod. 330 b/d

One important hot spot of 1957 was Algeria and the Sahara. All except the extreme northern part of Algeria is in the Sahara. French companies are working to explore and develop the Algerian Sahara and outsiders are permitted to come in as partners of French interests. Many individual oil companies have been granted concessions and were going ahead with operations on their leases. Everything looked rosy except the political scene and hope was seen for restoring a more peaceful situation this year. During the year 33 rigs operated in the Sahara, drilling 59 wells. Forty-nine of these found oil and gas reserves.

There were 9 geological and 26 geophysical crews operating during 1957 in the area.

The first strike, which occurred late in 1955 at Edjele on the border with Libya, was brought in by Compagnie de Recherches et d'Exploitation de Petrole au Sahara (CREPS). CREPS is owned 35%

How to Use 1957 Review

This brief survey of petroleum activity during 1957 is the latest chapter in worldwide progress. Incomplete by itself, it is the continued story of oil and gas operations presented annually. This particular progress report gives highlights of events in 125 nations, territories and protectorates.

Information comes from petroleum agencies of the countries and from companies handling the operations. We are deeply indebted for prompt and explicit data from these authoritative sources.

This material can be useful as a quick reference and combined with the 10 former annual reviews, provides chronological background for any or all countries that have any operations connected with petroleum.

Reports on the Soviet and its satellites are filtered from scarce information that appears in their publications. Plans and achievements are sometimes difficult to separate and we present them for what they are — our best guess.

by the Shell group — the remainder by French Government companies.

S. N. REPAL (owned 50-50 by French and Algerian governments) discovered Hassi Messaoud in 1956, but production was shut in until December, 1957 when a 6-in. pipeline from the field to Touggourt — 110 miles — was completed. Exports of oil began immediately and were running about 5000 to 6000 b/d at the end of the year.

Estimation of the reserves so far found in this rich new area run about 2½ billion bbl.

Interest, of course, is at a high pitch. Besides CFP (Algeria) and S. N. REPAL in the northern part, CPA and CREPS in the southern, the overseas companies include Royal Dutch Shell, British Petroleum, Phillips Petroleum, and others. Africa-Cities Service opened a Paris office and made joint application with French interests for concessions in the Sahara. Other interests are "Prepa" (30%) and "Francarep" (20%).

There is no refinery and the only previous production comes from the extreme northern part, Oued Gueterini field, discovered in 1949. Its daily production is 330 bbl; no development is being done.

Consumption runs around 12,000 b/d for petroleum products.

ANGOLA

Prod. 1100 b/d **R. C. 1885 b/d**

Angola is another bright spot in world operations. With commercial production in both the Bemfica and Luanda fields, the company Lobito Purfina, an associate of the Belgian group Petrofina, is reorganizing. The Angolan Government and Petrofina will each have 33⅓%, Lobita will hold 11⅓% and a similar amount will be available to the Portuguese public; 10% will be subscribed by other Portuguese interests.

Lobita Purfina's new topping plant was under construction at Luanda in 1957 and was completed this year. The plant does not satisfy the country's requirements, which run around 3000 b/d, so imports will have to continue. Products imports in 1956 were 32% higher than in 1955, and went up another 14% in 1957. Demand is small, but this is an example of the sharp increase in many small countries.

Initial refinery operations will depend upon supplies from Luanda field, as no line is laid to Bemfica. Together the two fields have about 5½ million bbl reserves.

ARGENTINA

Prod. 94,502 b/d **R. C. 217,600 b/d**
Runs 215,000 b/d

Last fall when the 50th anniversary of the discovery of the first Argentine oil field was celebrated Admiral Rojas, vice president and minister of trade and industry, reviewed his country's present standing in petroleum and the continued failure of Argentina to provide its energy requirements, which run about 200,000 b/d. Dr. Cueto Rúa gave present production as 94,502 b/d. Argentina's petroleum imports in 1957 rose about 7%, to 64 million bbl. Cost amounted to $250 million, about 20% of all export earnings. Oil imports this year are estimated at $367 million.

Despite this need for oil products and the failure of YPF to meet the needs, there is no change in the attitude of the government under Dr. Frondizi, Argentina's new president. One difficulty, of course, is not being able to acquire the capital needed to expand the industry. Dr. Cueto Rúa estimated that the cost of a 1957-60 development plan for YPF would be $431 million and 9 billion pesos. Even then necessary imports up to 1960 will cost $650 million.

After the 310 wells completed in 1957, YPF this year is making greater effort than usual under the new regime. Laughlin-Porter has made a contract to drill 40 wells on the Island of Tierra del Fuego. The company has shipped one small and two medium rigs to this southern area. Altogether there are 64 ries in the country, which drilled 310 wells; 278 producers.

Another project that seems to be getting underway is a 14-in. crude oil pipeline from the oil fields in the Province of Neuquen to the port of Bahia Blanca where YPF plans a 38,000 b/d refinery.

In the latter part of the year YPF officials were permitted to negotiate contracts with private concerns without authorization by the Argentine government. It negotiated a contract with M. W. Kellogg and Company to expand the Lujan de Cuyo refinery from its 12,600 b/d capacity to 37,800 b/d capacity at an estimated cost of about $17½ million plus local currency outlays of about 212 million pesos.

Esso and Shell both work within the country, but their activities are strictly limited. A few private Argentine companies are also in business but do not add greatly to the national production.

Occasionally there are rumors that various international companies have been invited into the country. General Peron made some proposals to Standard of California and it has been rumored recently that Gulf has had an invitation by the present administration.

AUSTRALIA

R. C. 207,400 b/d
Runs 202,000 b/d

Since 1900 the search for oil has been carried on in Australia and in Papua-New Guinea. The cost was $144 million and so far the results have been small but perhaps not insignificant because the oil companies continue to search. At Roma in Queensland, Lakes Entrance in Victoria, Rough Range, Western Australia, and Balmain, New South Wales, gas or oil has been found.

In the ten years since 1946 to the beginning of 1958, 84 wildcats have been drilled in Australia. During the 1955-56 period companies spent about $28 million — half on drilling and half on exploration.

Recently the Australian Parliament approved a proposal that a Government subsidy should be paid until 1961 of half the cost of drilling for stratigraphic information in approved locations in Australia and its territories. Annual cost of the subsidy to the Government is not to exceed $500,000. There has been an interesting response to this announcement and there is no doubt that stratigraphic drilling will receive a useful impetus.

In return for this aid exploration firms will be obliged to publish information derived from the drilling.

Australian demand runs 162,000 b/d. It is amply supplied by the refining capacity, and exports of oil products are made. Capacity is still building. Shell Refining is putting in a 6700 b/d catalytic reformer at its Clyde plant and a 11,000 b/d hydrodesulphurizer at its Geelong plant. Australian Oil Refining (Caltex) is constructing a distillation cracking unit at its Kurnell refinery, which will expand capacity from 31,000 to 42,000 b/d. Bitumen & Oil Refining (Aust.) is building a 12,000 b/d 2-stage crude plant at Sydney. A 10,000 b/d catalytic reformer is being installed at BP's Kwinana refinery.

AUSTRIA

Prod. 62,000 b/d **R. C. 45,600 b/d**
Gas 7.5 m³ cf/d **Runs 39,000 b/d**

The two state-owned oil companies in Austria, Oesterreichische Mineraloelverwaltung (OMV) and the Niederoesterreichische Gasvertriebs-AG (Niogas), have the unrewarding task of supplying Russia with a large share of its production as a peace payment. In 1956 this meant 40% of the total output of crude oil, but also meant that the refining capacity cannot be filled with domestic oil. Under present conditions the 23,000 b/d that goes to Russia, leaves only 39,000 b/d for refining and this puts a limit on consumption in the country.

Within the last few years the sinking trend of Austrian crude oil production, coupled with the heavy burden of delivery obligations to USSR has evoked several endeavors to make it possible for individual oil companies to re-enter the country.

An agreement was made in principal to return the 8800 b/d refinery at Lobau to the joint 50-50 ownership of Shell and Socony. Also, the two refineries belonging to Shell and Socony, respectively. There has been some discussion of joint ventures of OMV and private oil companies on a 50-50 basis.

About mid-year OMV found oil at Suessenbrunn 3 in Vienna at a depth of 7851-64 ft. Tests yielded approximately 150 b/d through an ¼-in. choke from the fourth Tortonian horizon. There were 851 wells producing at the end of the year.

OMV plans a new refinery at Schwechat, near Vienna, for processing Mideast crudes to take care of growing demand.

Consumption in 1957 was almost 6% more than the year before, which was on top of a 11% increase in 1956 over 1955.

Price controls have been dropped on crude oil and on several products.

BAHAMAS

In 1945 the government here invited private oil companies into the country with well conceived petroleum laws. Since then every year some exploration

has been carried on. Superior drilled the first well — a deep one — below 12,000 ft in 1946. Eight other companies came in and took part in the exploration in and around the Bahamas.

Latest announcement of intent to drill was in March, 1958 when Bahama California Oil Company and Bahamas Gulf Oil Company, subsidiaries of the U. S. companies, chose a site after two years of expensive seismic work over Cay Sal Bank. The test is located about 180 miles southwest of Nassau. The well will cost about $3 million and will be drilled to 15,000 ft from a platform in 30 ft of water. The companies have already spent $400,000 on seismic work. Zapata Off-Shore Company will do the drilling.

BAHRAIN

Prod. 32,031 b/d **R. C. 211,000 b/d**
Runs 185,000 b/d

Bahrain Petroleum Co., Ltd. (Caltex), drilled 17 wells in 1957, keeping its two rigs drilling throughout the year. Fifteen were added to the producing wells, which are now 143. One geophysical crew is operating.

At the refinery a 10,450 b/d Unifiner-Platformer was put into operation in October.

Bahrain and Saudi Arabia have agreed that the latter can grant oil concessions over certain offshore areas.

BARBADOS, W. I.

During 1957 Barbados Gulf Oil continued testing high pressure gas shows in its Springvale and Friendship wildcat tests, drilled to 12,178 ft and 10,799 ft, respectively. The latter marked the fifth in a series of tests Gulf has completed in its efforts to secure deeper production for this British Crown Colony.

Extension of Gulf's prospecting licenses were granted in February, 1957 to include the entire island and certain adjacent water-covered areas, amounting in all to some 138,000 acres. Extension covers the area formerly held by British Union Oil Company and the site of depleted shallow production.

BELGIAN CONGO

Two geophysical crews at work. One well drilled in 1957 had some shows. Exploration is carried on by Syndicat d'Etudes Geologiques et Minieres de la Cuvette Centrale, formed in 1951 as a joint venture of state and private enterprise. Prior to 1957 wells were drilled at Samba and Dekese in the northern and southern parts of the Central Congo Basin.

Consumption has risen to 7200 b/d from 6400 b/d in 1956.

BELGIUM

R. C. 144,300 b/d
Runs 130,000 b/d

Belgium's 7 refineries, running about 90% on Mideast oil, have a throughput near capacity. Consumption is about 100,000 b/d with product exports going to Western Europe. Since 1950 consumption in busy, prosperous Belgium has risen almost 2½ times.

The refinery of Société Industrielle Belge des Pétroles (Pétrofina and BP) has just been increased from 70,000 to 90,000 b/d, with the addition of a new Platformer and a new hydrodesulfurization unit, having each 10,000 b/d capacity.

Esso Belgium is adding a vacuum unit, 2500 b/d; Powerformer, 5600 b/d; Hydrofiner, 6900 b/d, and an asphalt plant, 1200 b/d.

All plants are at Antwerp except the small Shell refinery at Ghent.

BOLIVIA

Prod. 9796 b/d **R. C. 12,500 b/d**
Gas 9900 cf/d **Runs 6970 b/d**

Bolivia's change from a nationalized oil industry to an open-door policy has brought encouraging activity. Exploration and production have expanded; 15 million acres are under concession. When the laws were revised in 1952, output was 1500 b/d.

Glen H. McCarthy, who negotiated a concession in 1953, has sold his company's holdings of 960,000 acres and two rigs to Bolivian Chaco Petroleum Co., held by Tennessee Gas Transmission (35%), Union Oil and Gas of Louisiana (25%), Lion Oil (25%), and Murphy Corp. (15%).

Gulf has been active in Bolivia since 1956 when the petroleum law was further liberalized. The company acquired an operating interest in the Parapeti area of southern Bolivia. In 1957 Gulf was awarded three other concessions and planned a wildcat southeast of Camiri field. This 15,000 ft test is being drilled with the company's National-130 rig brought into southern Bolivia from Buenos Aires by rail after a 12,000-mile journey from the U. S. by water.

Other oil companies holding concessions in the Eastern plains are Andes Oil (Pure subsidiary with Sohio and Hancock as associates), Shell, Standard of California, Hancock, Standard of Ohio.

Bolivia and Brazil governments have agreed on development of the promising area north of Camiri. Yacimientos Petroliferos Fiscales Bolivianos (YPFB) the government company, will handle Bolivia's part.

White Eagle (with Western Hemisphere Corp. and Blackwell Oil and Gas) was granted a 2 million acre concession; Bolivian American (Oil and Gas Property Management, Dallas) was granted 365,000 acres; Bolivian Petroleum, 1,200,000 and Cataract Mining, 284,000 acres.

In 1957 there were 24 wells drilled in Bolivia with the 11 rotaries and 3 cable tool rigs in the country; 18 were producers and 6 were dry. Two geophysical and 5 geological crews were working.

Reserves are estimated at about 33 million bbl of oil; 27 billion cu ft of gas.

Refinery runs are only about half of the 12,500 bbl per day capacity of Bolivia's 5 plants. Consumption is 5064 b/d.

Pipelines are the key of Bolivia's industry. Production more than meets the 6960 bbl per day consumption and markets are far away in this landlocked country. In 1957 a 4½-in, 167-mile crude oil line was built from Camiri to Santa Cruz, on the railroad to Brazil. A 200-mile, 8½ and 10½-in. line from Sicasica to the port of Arica, Chili, is under construction by YPFB. Bolivian Gulf is meeting half the $10.5 million cost.

Argentina receives 2000 b/d from Camiri and Sanandita fields by way of a 6-in. line. Several pipelines are proposed.

BORNEO (Indonesia)

(See Indonesia)

Prod. 17,990 b/d **R. C. 65,000 b/d**
Runs 62,600 b/d

Royal Dutch/Shell conduct operations here for nationalized industry.

BORNEO (Br.)

Prod. 116,400 b/d **R. C. 50,000 b/d**
Runs 46,000 b/d

Brunei. Seria oil field averaged its highest output in 1957, more than 115,000 bbl per day. Shell's plans for the year included an expenditure of $9 million on exploration and drilling of 30 wells and $5 million on facilities.

Shell now has a mobile drilling platform and is increasing overwater drilling. Three other drilling platforms are permanent. One test in the South China Sea, 25 miles from the coast, was abandoned at nearly 6000 ft.

Sarawak. Miri field produces about 1300 bbl per day. No development wells were drilled. Sarawak Oilfields (Shell) has spent $23 million to explore the country since the end of World War II. It drilled 17 deep tests without results. In 1957 the company surrendered 36,650 sq miles of leases, retaining 10,850 sq miles. Two dry holes were drilled offshore and a mobile drilling platform is on order for further exploratory tests.

Runs at the Lutong refinery are slightly below capacity.

BRAZIL

Prod. 43,000 b/d **R. C. 135,000 b/d**
Gas 21,500 m³cf/d **Runs 122,000 b/d**

Last year marked a turning point in Brazil's oil operations. In the last 5 years consumption virtually doubled to about 200,000 b/d. In one year — 1957 — production almost doubled, and capital funds for Petrobras (State oil entity) were doubled (to $58 million). Production figures are from Petrobras although several estimates for the year are lower. E. Ospina-Racines gives 27,700 b/d. This may be end of year figure.

This kept 27 geological and 13 geophysical crews operating. It drilled 89 wells with 45 rigs; 51 wells were producers, 38 were dry. Drilexco and Parker Drilling are operating Petrobras' rigs.

Exploration was concentrating more in the Amazon basin, which is difficult and expensive. The discovery at Nova Olinda in 1955 has not been fully evaluated. The fifth well is being drilled in the area.

Refining capacity has been increased and further expansion is under construction. Petrobras plant at Bahia was expanded from 7000 to 37,000 b/d and the Mataripe is being expanded to 36,000 b/d capacity. The company has begun construction of a 90,000 b/d refinery at Rio de Janeiro. Texaco is to supply 15,000 b/d Mideast oil and has made a 5-year, 6% loan of $6 million toward building costs.

A private Brazil firm (COPAM), built a new 5000 b/d refinery at Manaus on the Amazon. Crude is supplied from Eastern Peru by river barges. Markets must be built up as the Amazon valley is not developed. The other 7 refineries are in industrial centers. Hydrocarbon Research Inc., did the engineering and construction supervision of an ethylene plant at Cubatao refinery. Cost ran some $3 million.

A new 12-in. pipeline was constructed from Catu field to Madre de Deus deep sea terminal. The 40-mile line has one pump station at Catu and an intermediate heating station at Lamarao. It is designed to handle high paraffin content crude oil. The pump station is equipped with reciprocating steam pumps, which will be replaced by 3 centrifugal units in the near future.

BRITISH GUIANA

California Oil Company, British Guiana, Ltd., a subsidiary of Standard Oil of California, was incorporated March 19 in Georgetown, B. G., and on April 15 was granted a license to explore approximately 16,000 sq miles in this country, east of Venezuela, mostly in the offshore area. Plans are presently being made to initiate exploration activities.

BRITISH HONDURAS

British Honduras Gulf Oil Co., as a result of continuing geological field studies

On the Island of Tierra del Fuego, Magallanes, Chile, is the Manantiales gasoline plant, which belongs to the state-owned company, Empresa Nacional del Petroleo. Photo was sent by Mario Vargas Rozas, ENAP publicity director, who protested a reference to "the remote Chilean jungle location" in an article on rigs. Actually it's hard to find a tree in this area.

and an evaluation of its earlier Hillbank and Yalbac wildcat tests, has made acreage selections and converted its prospecting licenses in the area south of the Maya Mountains to mining leases. It is pursuing an active exploration campaign on its concession areas in the north.

On its northern prospecting licenses of 4,500,000 acres Gulf and Shell are engaged in a two-rig wildcat program. This effort was sparked by the spudding of Roaring Creek No. 1 in October, 1957, abandoned at 2680 ft. Currently drilling are Tower Hill No. 1 and Retaliation No. 1. Gulf and Shell hope to complete at least 7 wildcats in the present campaign before November, 1958. Kerr McGee is drilling contractor.

Oil prospecting rights have been granted to a U. S. company, Bandini Petroleum. The rights cover about 1,870,000 acres, plus a further 145,000 acres farmed out from Gulf leases in the southeast.

BULGARIA

Prod. 5600 b/d? **R. C. 7500 b/d?**
Runs 7000 b/d?

Gorubso, state-owned oil entity, has increased production sharply, according to reports from this Communist country. About 1600 b/d were exported, leaving some 4000 b/d to fill demand.

Production is from the Dobruja area in the northwest.

Largest refinery is that at Varna, on the Black Sea, which is said to have a 6800 b/d capacity.

BURMA

Prod. 6850 b/d **R. C. 7000 b/d**
Runs 6800 b/d

Burma Oil Co. (1954)† produced 2,500,375 bbl in 1957 compared with 1,395,304 bbl in 1956 from the Chauk and Lanywa fields. This was refined partly in Chauk and partly at the new 4000 b/d BOC (1954) refinery in Syriam, near Rangoon, which came on stream in March, 1957.

The government-owned "Inland Water Transport" moved crude stocks to Syriam using its fleet of oil barges with pusher tugs.

Several hundred barrels of oil per day were also produced and refined by local operators in the Yenangyaung field.

BOC drilled 16 development wells in the Chauk and Lanywa fields and continued to recondition old wells.

Four party-months of reflection seismic work were carried out in the Irrawaddy River delta and a location was staked at Kyaiklat for the first test well to be drilled in 1958, with Santa Fe Drilling Company as contractors.

In December BOC spudded in an exploration well (No. 5) on the Ondwe dome and this had reached 4201 ft at the end of the year with some shows of gas. The steam rig is being fuelled by gas obtained from a shallow well (No. 6). Between 1919 and 1927 four wells were drilled on this dome with depths up to 4549 ft, finding only small gas shows.

†Refers to reorganization in 1954, which brought in Burma government.

CAMEROUNS (French)

Imports of 2000 bbl per day for consumption here is a large increase. SEREPCA (owned principally by Bureau de Recherches de Petrole) has the only concession here. There have been promising shows of oil and gas from the drilling program.

CANADA*

Prod. 498,600 b/d **R. C. 768,000 b/d**
Gas 294 m^3cf/d **Runs 653,800 b/d**

Canadian consumption rose to 745,000 b/d for 1957. This meant imports of 165,000 b/d crude oil and 89,600 b/d products were needed.

During 1957 the 247 rigs in Western Canada drilled 2963 wells; 1891 were oil producers, 198 gas wells, and 874 were dry. Estimates of present reserves in Canada are 3269 million bbl, including natural gas liquids. Gas reserves are about 21 trillion cu ft.

New refineries that will be added to the 43 now operating in Canada are those of B. P. (Canada) at Ville D'Anjou, Quebec, with a 30,000 b/d capacity; British American at Port Moody, B. C., 20,000 b/d; Cities Service at Bronte, Ontario, 20,000 b/d; Irving Refining Co., a $40 million plant at E. St. John, New Brunswick.

Phillips and Pacific Petroleum Ltd. completed a joint-interest 4000 b/d plant near Taylor, British Columbia, for converting natural gas liquids into motor fuel and diesel fuel, and separating liquefied petroleum gas. Canadian Oil, Sarnia, Ontario, plans a 20,000 b/d addition to its Sarnia, Ontario, refinery.

In the first public sale of prospecting permits in the Athabasca tar sand area, permits were sold for 300,000 acres to Northwestern Exploration (Texaco), French Petroleum, and Shell.

The Trans-Canada Pipeline (gas) was 60% completed at the end of the year.

A group of independents, Alberta Crude Producers, applied for authorization to form a new pipeline company to construct a line to parallel Interprovincial's pipeline to Toronto.

*For detailed review see "Canada Has Good Year" by H. G. Cochrane, The Petroleum Engineer, March, 1958, Page E-1.

CEYLON

The government of Ceylon has asked Russia to send a team of experts to prospect for oil in this Indian Ocean island, it is reported.

Russian technologists recently reported to Ceylon's ambassador to Moscow that the island should have "considerable underground oil deposits or deposits under the sea close to the shore."

CHILE

Prod. 11,800 b/d **R. C. 20,700 b/d**
Runs 19,000 b/d

The Mining Committee of the Chamber of Deputies is still working on Chile's new oil bill. Tentative features are that local and foreign companies would be allowed to search for and exploit oil, along with Empresa Nacional del Petroleo. The state oil company is at present the only one with the right to conduct oil operations. It has not been decided whether the bill would reserve Magallanes province for ENAP or not. ENAP drilled 67 wells with its 5 rigs, 35 of which were producers.

ENAP's Concon refinery and the three smaller topping plants do not fill the 38,000 b/d consumption, but they are running near capacity.

A new products line is being built from the Concon refinery to San Diego. The companies include ENAP and Esso, each 26%, and a local concern COPEC, 48%.

Plans are to double the capacity of the Concon refinery to include a 24,000 b/d atmospheric and vacuum distillation unit, a 12,000 b/d orthoflow fluid catalytic cracker and gas recovery unit, a 6000 b/d desulfurization and reforming unit, and 1100 b/d alkylation unit. M. W. Kellogg, of New York, will plan and supervise the addition.

CHINA

Prod. 16,000 b/d? **R. C. 18,000 b/d?**
Runs 16,000 b/d?

Communist China combines crude oil and synthetic oil from coal and shale but petroleum output runs about 55 percent of the total 30,000 bbl per day output

claimed for 1957. This was the planned production for 1956.

There is extensive exploration in Sinkiang, where the Karamai field is promising, in the Gobi desert and near the Tienshan Mountains.

A refinery has been built in the Tsaidam area, Sikiang and one is in progress at Lanchow. The latter will have a 20,000 bbl per day capacity when it is completed in 1959.

Work began on China's first oil pipeline, a 91-mile line connecting the Karamai oil field with the Tushant refinery in Northern Sickmang, the Communist China news agency reported.

It is said the pipeline, to be completed this year, will carry 400,000 to 500,000 tons of crude oil annually. Oil now is being carried by truck.

COLOMBIA*

Prod. 125,327 b/d **R. C. 66,200 b/d**
Runs 42,000 b/d

Big news in Colombia this year was the opening of International Oil Company's Cartagena refinery with a 26,500 b/d capacity. Completely new, it is South America's latest in modern refineries. Runs averaged much lower because the Intercol plant went on stream in the fall of 1957.

Consumption now reaches about 44,000, so refining capacity can now fill domestic needs and products can go to neighboring states.

Exploration continues with some diligence, as it has since reformed petroleum laws in 1955. Besides the state-owned company, 15 other companies hold concessions.

Colombian Sun Oil made a working agreement with Mobil Oil de Colombia and Intercol for the exploitation of a 750,000-acre concession in the Sinu River area of northern Colombia. Pure Oil and United Carbon are associated with Colombian Sun in this arrangement.

Colombia-Cities Service Petroleum (37½%), state-owned Empresa Colombiana de Petroleos (25%), and Richfield (37½%) carried on geological and geophysical work through 1957 and scheduled additional work for 1958 on their 2,200,000-acre Carare concession. Two seismic crews and two geological crews are active. One drilling rig operated during 1957 and will continue through 1958.

A concession for a $20 million offshore venture in Colombia's Tolu Bay and Morrisquillo Gulf was granted John W. Mecom of Houston. His company is to supply 75% of the investment and Empresa 25%.

Texas Petroleum carried out exploration operations, signing contracts for five concessions covering more than 2 million acres. It extended the Velasquez field northward, completing several new producers during the year.

Colombian Petroleum (Texas and Mobil) completed 7 successful wells in its Cicuco field, discovered in 1956 in north central area, far from other fields.

Altogether, there were 22 rigs in the country, used to drill 164 wells, 136 of them producing oil. More than 66 million acres are under lease.

COSTA RICA

During the year 1957 the Costa Rican subsidiary of Union Oil of California continued its active exploration program on its 3½-million-acre concession. The scene of drilling activity shifted to Central Limon during the latter part of the year.

One rig in the country drilled two tests, Cocoles No. 3 and No. 4, before spudding in Victoria No. 1, which was drilling at 6660 ft at the end of the year. The first two were dry although close to Union's discovery in 1956, near Panama. The discovery well began making salt water and had to be shut in.

Consumption is 3450 bbl per day, all imported products. There are no refineries.

CUBA

Prod. 1002 b/d **R. C. 84,000 b/d**
Runs 40,000 b/d

Perhaps this year will be the turning point for Cuba. It is still buzzing with activity. Though production is down slightly, refining capacity has more than doubled.

Seven geological and three geophysical crews operated most of 1957. There are 20 rigs in the country; 83 wells were completed, of which 25 were producers.

During 1957 Cuban Gulf arranged further exploration of its Cuban holdings by concluding farmout arrangements with the Cuban Kewanee Co. Cuban Kewanee is currently drilling a projected 13,000-ft test on Gulf's Punta Alegre concession for an earned interest; this wildcat, Collazo No. 1, was approaching 12,000 ft depth in mid-February. The same operator completed some 30,000 ft of hole on Cuban Gulf's Noguera Quinta concession in February, 1957 when it abandoned Triana No. 1 at 1880 ft as the 13th test on this block. Escambray No. 1 on Gulf's Santa Clara concession was abandoned by Cuban Consolidated in August.

Atlantic Refining continued exploratory drilling during 1957 on a modest scale. One deep test well was completed in Pinar del Rio Province and two other test wells were drilled under farmout arrangement in the same region. All three wells were dry holes. The company has an interest in a deep test well on the north coast of Camagüey Province, Cuba, which was drilling at the end of the year. Title processing work was continued during 1957 and titles obtained to substantial additional acreage.

Cuban Stanolind Oil Company plans to drill the first offshore test well ever drilled in Cuban south coastal waters. The company completed two exploratory wells as dry holes in Oriente Province, near Santiago de Cuba.

Reports are that Cuban Gas Transmission Co. is working on the idea of a gas pipeline from Mexico to Cuba to Florida — mostly underwater.

Esso Standard completed expansion of its Belot refinery from 9400 to 35,000 b/d. Shell opened its 27,000 b/d refinery at Havana early in the year. Texaco's $15 million plant at Santiago was put on stream also in 1957. It was the first major refinery outside the Havana area. Copetrol Oil Refinery Co. plans a 15,000 b/d refinery at Nuevitas.

Consumption is 61,025 b/d and runs probably equal consumption at present.

CYPRUS

The Cyprus Government has granted Forest Oil Corporation, of Pennsylvania, an oil exploration license covering the major part of the Colony and its territorial waters. A company associated with IPC relinquished its concession in Cyprus in January 1949.

CZECHOSLOVAKIA

Prod. 5000 b/d? **R. C. 14,000 b/d?**
Runs 12,000 b/d?

USSR had an agreement to ship 12,000 b/d crude and products to this satellite in 1957 in return for machinery and equipment.

Consumption is rated at about 25,000 b/d, part of which is met by oil from lignite. Figures on production of crude petroleum and synthetic oil are combined. The 5000 b/d output (from the fields near Austria) is an arbitrary separation of crude oil figures.

DENMARK

R. C. 750 b/d
Runs 534 b/d

Danish American Prospecting Co., holder of exploration rights covering the whole of Denmark, spent some $10 million seeking oil before 1954. Operations were suspended then and in 1957 Jersey Standard took over the company from Gulf. Two geophysical crews are working in the country and in December a test well was spudded in, not far from the North Sea Coast. It was abandoned at 6430 ft early this year.

Maersk is building a pyrolysis plant near Copenhagen, which will have a capacity of 2750 b/d. Virgin naphtha will be the feed stock.

Consumption of oil products in the country is about 77,000 b/d.

DOMINICAN REPUBLIC

A new law states foreign concerns may not develop oil and gas resources.

ECUADOR

Prod. 9500 b/d **R. C. 6300 b/d**
Runs 5700 b/d

Ecuador has no state company, but the government has made it difficult for outsiders to operate because price of products sold locally are set by the government — sometimes on an uneconomic level. Largest operator is Anglo-Ecuadorian Oilfields. Only other operator is Manabi Exploration.

Production is all on the West Coast, adjoining Peru. Nearly 35 million acres are under concession.

Ecuador should be able to export some crude oil and even some products when the Anglo Ecuadorian refinery at La Libertad is completed. This will add a 7700 b/d atmospheric distillation unit and a 6000 b/d thermal cracking unit. Cost will run close to $4 million.

Anglo Ecuadorian has 8 rigs operating in the country and drilled 80 wells in 1957 — 63 of them producers. Three geological and one geophysical crews are working for the company. It acquired a 30,000-acre concession offshore from its Ancon concession and is drilling its first directional well there.

EGYPT

Prod. 47,400 b/d **R. C. 90,000 b/d**
Runs 53,000 b/d

Because of the increased production of International Egyptian (Petrofina AGIP et al), especially Belayim field, discovered in 1955, Egyptian production went up sharply this year. This output still amounts to only ⅔ the supply needed for Egypt and some 24,000 b/d are imported, most of which is crude oil.

One promising field, Abu Rudais, was discovered in 1957 by Eastern Petroleum Co. International Egyptian holds 51% interest in Eastern; the remainder is owned by Egypt's own General Petroleum Co. and Cooperative Petroleum Society.

Conditions in Egypt outside of this rise in crude output are somewhat uncertain. Existing fields that belong to Anglo Egyptian Oilfields, a United Kingdom registered company, and Mobil of Egypt are closely controlled by the Egyptian

*The Petroleum Engineer, February, 1958, issue carries a comprehensive collection of articles on Colombian operations.

In Formosa 300 wells were drilled in an intensified search for oil. This pumper discovered Chutauchi field.

government. British and French interests have been taken over by the government until the Suez situation is resolved.

Sahara Petroleum (Conoco, Cities Service, Richfield, and Oasis Oil — which is Ohio Oil) has been exploring its 88,000 sq miles in the western desert and offshore in the Mediterranean.

By the end of 1957 seven dry holes had been completed by Sahara Petroleum in the western desert. The company is still running one drilling rig. Other than drilling, the only exploration field activity this company has was one seismograph crew operating until July 1.

Of course, it is to be expected that General Petroleum, formed in 1957, will have every advantage in Egyptian oil activities. Licenses were granted to it recently over areas for which Anglo Egyptian Oilfields and Mobil of Egypt had applied as long ago as 1948.

ETHIOPIA

In 1945 Sinclair was granted a concession covering this entire country — about 350,000 sq miles. The company carried on extensive geophysical and geological work and drilled a number of wells, the deepest one going to 10,000 ft. No commercial production was found and in March, 1957 the company relinquished its concession.

FINLAND

R. C. 17,000 b/d
Runs 15,400 b/d‡

In September, 1957 Finland's new refinery went on stream and reached its full capacity in early October. Total production was 1,385,000 bbl and 550,000 cu ft of gas. Neste O/Y, a state-owned company, operates the refinery, which is near Turku. Shell supplies 40% of the crude; Gulf Oil, 10%; and USSR, 50%.

Consumption in Finland averaged 33,776 b/d in 1957, so that even with the opening of the refinery about 12,000 b/d of products must still be imported.

FORMOSA

Prod. 60 b/d **R. C. 30,000 b/d**
Runs 18,000 b/d

Chinese Petroleum Corp. added catalytic cracking and catalytic reforming units to its refinery at Kaohsiung last year. Construction was financed by a 10-year loan of $2 million from Gulf, and a 5-year loan of $700,000 from Caltex. The companies supply Mideast crudes. Plans for further expansion include an alkylation unit in 1958 to produce aviation gas.

An intensified search for oil on the island continues. The small production is useful, but the economy would be helped tremendously if oil could be found in quantities. During the past 2 years about 300 wells have been drilled without noteworthy success, but 75% of these have produced some oil or gas. These were drilled in the foothills of central Formosa and now exploration is being carried on in the western plains.

‡Present runs.

FRANCE

Prod. 26,760 b/d **R. C. 637,000 b/d**
Gas 54,000 mcf/d **Runs 450,000 b/d**

One of the phenomena of the oil industry is the growth of oil production in France in recent years.

Exploration is going ahead at an increased pace. Forty-five geological and 49 geophysical crews operated in the country in 1957. Forty-three drilling rigs have drilled a total of 143 wells during the year, most of them wildcats; 25 of these are producing.

France has welcomed outside capital in searching for its oil. There are now a large number of companies holding concessions in the country. Among these are Jersey Standard, Caltex, Socony-Mobil, Shell, and BP.

One of the most interesting booklets on France's oil prospecting has been published by the Secretary of State for Industry and Commerce. It can be obtained by writing to the government. It includes in French and in English information on oil prospecting in France and its overseas territories.

Early this year Petrorep drilled the first successful wildcat in the Paris Basin, about 15 miles northeast of Paris.

Reserves at the present time are estimated at 147 million bbl of oil and 4½ trillion cu ft of gas.

A new 75,000 b/d refinery is being constructed by Esso Standard in the Bordeaux area. CFP and CFR have begun construction of a plant at Strasbourg which will ultimately have an 80,000 b/d capacity. Omnum Francais de Petroles plans a major refinery in Chalon-sur-Saone. Several others of the 13 operating refineries in France are carrying on expansion projects. Shell's Petit Couronne plant is being increased by 39,000 b/d.

In 1957 a 12-in. 60-mile crude oil pipeline was built from Parentis to Ambes; also, a system of gas feeders were under construction at Lacq.

According to the above booklet, in 1956 a total amount of about $115 million was spent for oil exploration: $35 million in France, $25 million in Central Africa and Madagascar, and $55 million in Africa, including the Sahara.

Inland consumption in France was 338,000 b/d in 1957, which called for imports of 462,000 b/d crude oil and 53,000 b/d products. Exports were 87,000 b/d.

One interesting result of the Suez crisis is that the Minister of Industry and Trade has decreed that the level of stock maintained by French oil companies should be higher. If stocks are in the form of products, they must be equivalent to three months' consumption.

FRENCH EQUATORIAL AFRICA

Prod. 3308 b/d

In the Gabon basin great headway has been made in production. Further work has been done at Ozouri and Pointe Clairette, both discovered in 1956. Two new fields, M'bega and d'Aninba, were found last year. Latest show of oil was found by a well drilled near Pointe Noire, Middle Congo. Operations are carried on by Societe des Petroles d'A.E.F. (SPAEF), in which the state BRP has an interest. Forty wells are now producing in the 11,000 sq mile basin, and 12 rigs are operating. Of the 53 wells drilled in 1957 31 were producers. At present one geological and 6 geophysical crews are working. Early estimates of reserves in this country, which began producing only in 1956, are 28 million bbl.

FRENCH WEST AFRICA

French West Africa includes a number of areas along the West Coast: Senegal, French Guinea, the Ivory Coast.

Consumption is growing rapidly in these awakening regions. Last year it was about 67,000 b/d and this year it will probably by 75-80,000 b/d. There are promising areas and France's Bureau de Recherches de Petrole is searching in Senegal and the Ivory Coast. Four geological and 6 geophysical crews have been working.

Societe des Petroles du Senegal drilled 5 wells last year with the one rig it had operating. This company, formed in 1956, is owned by BP, 50%; BRP 30%, and two other French companies, 10% each.

Plymouth Oil Co. negotiated with Societe Africaine des Petroles (80% state owned) for joint exploration of 2.4 million acres on the Ivory Coast. In 1957 the two rigs operating here drilled two dry holes. Two geological and two geophysical crews are exploring the Ivory Coast.

A new area, the Niger basin, in the French Sudan, is being surveyed by BRP.

GAMBIA (BR.)

British Petroleum and Bureau de Recherches de Petrole have a 50-50 interest in an exploration license in this protectorate on the West Coast of Africa. BP is the operator. No drilling has been carried out, but preliminary information has been obtained.

GERMANY (EAST)

Prod. 60 b/d? **R. C. 46,000 b/d?**
Runs 41,000 b/d?

A double-duty pipeline is proposed to run from Stettin to Czechoslovakia with various sidelines. The line would be used alternatively for north-south transport, picking up oil from tankers at Stettin and for south-north transport — that is, taking Austrian, Russian or Rumanian oil shipped to Czechoslovakia via the Danube.

Most of East German's output is from synthetics. However, a small field near Fallstein produces.

The 1956-1960 five-year plan for East Germany calls for a new effort to explore for oil. Output of East German plants is estimated at about 46,000 b/d. This is made from both oil and lignite and separate figures are not given.

GERMANY (WEST)

Prod. 77,023 b/d **R. C. 400,000 b/d**
Gas 34,550 mcf/d **Runs 230,400 b/d**

A. M. Stahmer publishes twice a month German Oil Information Service in which he has excellent coverage of West Germany and her neighbors. In his review of 1957 he says "To everybody's surprise the international sales market did not, like dry sponges, suck up the flood of oil from the reopened sluices after the Suez crisis, but excessive supplies resulted in over-filled stores, idleness on the part

of the tanker fleet, and above all, in price setbacks." The three factors he names that contributed to this fact were: (1) European countries had provided for stores of oil in the face of the Suez crisis; (2) restrictions on imported oil in the United States, and (3) general business did not expand.

In Germany consumption rose to 320,000 b/d, which is 11½% higher than it was in 1956. One-third of this rise was in fuel oil. Crude production at 77,000 b/d was up 12.9% from 1956. Output of West Germany's natural gas fields, however, declined slightly due more to decrease in demand than potential out-put.

Refining was up slightly by 4.3% over 1956. Capacity continues to grow. New plants under construction at the present are: Deutsche Shell AG, Godorf near Cologne, 80,000 b/d; Esso AF, Cologne, 70,000 b/d; Purfina Mineralolraffinerie AG, Duisburg, 60,000 b/d; British Petroleum, Dinlaken, 80,000 b/d.

Shell's Harburg-Hohe Schaar refinery is being expanded to 50,000 b/d; Esso AG, Harburg, to 60,000 b/d; and Mobil's Bremen-Oslebshausen refinery, to 25,000 b/d capacity.

Getty Oil is reported to have plans for a refinery in the lower Rhine area of West Germany; DEA plans one in the Karlsruhe area, and Erdolwerke Frisia one at Emden.

One crude oil line is being constructed from Wilhelmshaven to Cologne, some 230 miles.

Estimated reserves at the present time are 472 million bbl of oil. There is still considerable exploration, with 70 geophysical crews working in the country. Out of 561 wells drilled in 1957, 400 were producers, bringing the total wells producing up to 3600. Some 170 drilling rigs are operating in West Germany.

One remarkable episode of the petroleum industry is the growth of West Germany's oil operations since World War II. Since 1945 production has grown sevenfold.

GHANA

This new state within the British Commonwealth was formerly the Gold Coast. Gulf, the only operator, carried on exploratory drilling through most of 1957. Epunsa No. 1 was completed early in the year at a depth of 6791 ft, after which Bonyeri No. 1 and Kobnaswaso No. 2 were drilled at 8190 and 4513 ft, respectively. Drilling was suspended on November 19 and the rig removed to Takoradi and prepared for shipment to Cabinda.

GREECE

R. C. 30,000 b/d

The Greek Government completed a 30,000 b/d refinery near Athens and advertised for bids to operate the plant. Tenders were submitted by 6 companies, but were unsatisfactory so that the government had the $20 million plant on its hands for some time. Early this year (1958) a 10-year lease was awarded a company formed by Socony-Mobil, the ship owner, Stavros Niarchos, and the Greek Bodossakis group. Socony will supply the crude.

Consumption runs over 28,000 b/d and the refinery should fill the present needs if distribution is effective.

C. Deilmann Bergbau GmbH carried out exploration work in Greek Thrace in cooperation with "Hellenic Sun" Oil-Field Exploration and Development S.A. Exploration has continued since 1952. In 1957, the well "EVROS 1" was drilled. It proved to be dry, was abandoned in August in the Mesozoic graywacke-series at 8722 ft.

GUATEMALA

This small country (largest of Central American nations with a population of 3.2 million) survived its worst blow when President Carlos Castillo Armas was assassinated by one of the palace guards in August. A period of political uncertainty followed. In January of this year a new president, Miguel Ydigoras Fuentes, was elected. It is hoped that the interrupted progress Guatemala has made will be resumed.

U. S. oil companies have invested some $7 or $8 million in exploration, mostly in Peten and Izabal provinces in the north. A large number of major companies and several smaller ones have concessions. One of the last granted in 1957 was to Argus Petroleum (Husky, 51%), which brought its total acreage to 727,000 acres. Aerial magnetic surveys and gravity work was done on this concession.

Atlantic Refining carried out a limited program of geological and geophysical work in association with Tidewater and Sohio in several areas. Some exploratory drilling is planned for 1958.

Texaco conducted some gravity meter exploration work on concessions owned with others in El Peten. Prospective territories are being investigated in several areas.

An application was filed by Breaux Bridge Oil Refining Co. of Louisiana to establish an oil refinery with 2000 b/d capacity near Santo Tomas on the Caribbean Coast.

Consumption in Guatemala runs about 7500 b/d. Consumption has shot up, indicating rapid development of the country.

HAITI

Commonwealth Oil Company, Houston, Texas, continued its exploratory (primarily surface and photo geology) in Haiti during 1957.

HAWAII (U. S. Territory)

R. C. 3000 b/d

Standard of California owns a small refinery near Honolulu now operating. This company has for several years proposed a larger refinery in the territory.

HONDURAS

Honduras has put into effect a new petroleum law which will regulate exploration, production, refining, pipelining and other transportation of all hydrocarbons. The state may concede the right to develop oil to private enterprises, but only Honduran nationals may be granted offshore concessions, or within 40 kilometers of the coast or neighboring countries. Two-year permits are granted under the law for exploration.

Two companies are working in this Central American country — Petroleos Hondurenos S. A., owned by 7 U. S. independents, and Compania Petrolera Hondurena S. A., in which John W. Mecom has controlling interest. The former has a 11 million-acre concession and the latter a 48 million-acre concession, on which one dry well has been drilled.

HUNGARY

Prod. 14,000 b/d? R. C. 25,000 b/d? Runs 19,000 b/d?

Hungary's oil production has fallen again this year. Highest production was in 1955, when it reached 33,000 b/d, according to present reports. Our estimate for that year was 25,000 b/d. Report stated that 1956 production was 25,000 b/d and this year another drop was registered. Hungary must now depend upon imports from the USSR and Bulgaria. Plans are to increase production this year.

We find little refining news from Hungary. A refinery was planned to process the Nagylengyel field crude, but production there fell heavily and it is not known whether the refinery was built.

INDIA

Prod. 9335 b/d R. C. 101,200 b/d Runs 97,250 b/d

At the end of the year negotiations were completed between the Government of India and The Burmah Oil Co. regarding formation of a new company, Oil India (Private) Ltd., (Burma, ⅔-Government ⅓), to develop the Nahorkatiya, Hugrijan and Moran concessions and to arrange transportation of the crude to refineries where it will be processed.

The Government plans to erect two refineries, one in Assam with a capacity of about 20,000 b/d and one at Barauni in Bihar, with an annual capacity of 30,000 b/d. Negotiations with Romania are in progress to construct the one in Assam on long term credit.

Assam Oil (subsidiary of Burmah Oil) completed 8 party-months of reflection seismic work in Upper Assam during the year, mainly in the Hugrijan and Moran concessions, but with some work at the east plunging end of the Digboi fold.

The company completed 8 exploration and extension wells in the neighborhood of Nahorkatiya to depths of about 10,000 ft; of these 4 are potential oil producers with one marginal, two gas wells and one dry hole. Five wells were completed in Moran to depths of about 12,000 ft; of these 3 were potential oil producers and 2 dry holes.

Some development drilling was undertaken in the Digboi field, 6 wells being completed.

Production from Digboi totalled 2,165,279 bbl compared with 2,408,792 bbl in 1956. Production from Nahorkatiya, Hugrijan and Moran (mainly Nahorkatiya) totalled 1,242,094 bbl compared with 671,858 in 1956. This crude was moved to the Digboi refinery mostly by pipeline from Nahorkatiya.

Standard Vacuum has drilled two test wells in West Bengal. Under an agreement signed in December 1953 the Indian Government is participating in Stanvac's exploration in the West Bengal basin, bearing ¼ of the cost up to $5 million.

Stanvac is increasing the capacity of its Bombay refinery to 35,000 b/d from 28,000 b/d.

The Caltex refinery at Visakhapatnam on the eastern coast of India went into full operation in 1957. Costing $31 million, its capacity is 13,500 b/d. At the end of the year the refineries were apparently running close to capacity. Even then some products must be imported to meet the estimated consumption in India of 108,000 b/d.

INDONESIA

Prod. 315,790 b/d		**R. C. 243,800 b/d**
Sumatra	**290,500**	**Runs 235,700 b/d**
Java	**7,300**	
Kalimatan	**17,990**	

Since March the Indonesian Republic has been on the verge of cracking up. Oil operations have held up remarkably well in the face of political strife.

Largest islands are Sumatra, Borneo (Kalimatan), Java, and the Celebes. U. S. oil companies have poured over $200 million into this area. Caltex has a new field at Buri, Sumatra. Stanvac is developing its Lirik field and has a refinery near Palembang. Royal Dutch/Shell's oil fields in South Sumatra, Java, and Borneo are still in operation; North Sumatra oil fields

have been closed down since WW II. Indonesian production rose to 315,790 b/d despite the uncertain conditions — all the increase came from Caltex's Minas field in Central Sumatra. To handle the extraordinary 135,000 bbl a day from the Minas field, an 18-in. pipeline was added to the 12-in., which takes the crude 16 miles down the Siak river. Two new fields in the region are ready to be developed — Duri and Bekasap.

Stanvac's investment program includes the modernization of its Sungei Gerong refinery in South Sumatra and development of the Lirik area. This includes an 88-mile, 8-in. pipeline, with a 3-in. hot water pipeline laid under it to keep the waxy crudes flowing to the Buatan river terminal. Stanvac's other Sumatran fields are older and production is dropping.

No new licenses have been granted for some time, although it was reported that a Canadian company — New British Dominion Oil Co., of Calgary — was negotiating for exploration rights.

Consumption in the country runs about 90,800 b/d. Exports include about 146,000 b/d of crude and 150,000 b/d of products. Imports run 72,300 b/d of crude and 3500 b/d products.

First catalytic cracker in southeast Asia was completed at Stanvac's Palembang refinery at a cost of $8 million.

IRAN

Prod. 716,000 b/d — **R. C. 538,000 b/d**, **Runs 314,000 b/d**

Crude oil production in 1957 in the Consortium agreement area of Iran reached its highest record, exceeding 1956 output by ⅓. Payment to Iran totalled $213 million.

A new project for development of the Gach Saran oil field and for a tanker terminal at Krarg Island are new projects for the organization. At Agha Jari a new gas oil separation unit is being constructed and a 16 to 20-in. pipeline is being built from the field to Bandar Mashur where two jetties are in construction. Expansion will cost $140 million in the next few years. This will cover exploration work, which now takes 8 field parties and a drilling program, which calls for 4 rigs on development wells and 2 on exploration.

Throughput at Abadan refinery was 34% higher than in 1956. Rehabilitation of the major refinery units begun at the end of 1954 was virtually completed, but no new units were constructed. The state-owned entity is expanding its Kermanshah refinery.

The big news in Iran in 1947 was a new oil law which leaves wide powers to the state-owned National Iranian Oil Co. to negotiate agreements with foreign or domestic concerns for oil exploration and development outside the Consortium's area. Terms are more favorable where NIOC is in partnership as much as 30%. First agreement. was made with the Italian state oil company, AGIP, with 50% participation by NIOC.

Next agreement was between NIOC and Pan American Oil Co., a subsidiary of Standard of Indiana. By the agreement Iran will receive 75% of the net profits including state taxes, and Pan American will receive 25% and provide all the capital. Pan American will spend $82 million within the next 12 years.

Offshore concessions were opened in the Persian Gulf in the last part of 1957, which interested a number of oil companies.

One projected pipeline is to be built from the NIOC Qum oil field in northern Iran to the Mediterranean port of Iskanderun. Iran recently began negotiating with Turkey for the outlet. The line would be about 1000 miles long and would cost about $450 million. It is to be financed by the Iranian Government and Turkey would share in the profits.

IRAQ

Prod. 443,700 b/d — **R. C. 42,550 b/d**, **Runs 38,000 b/d**

Due to the destruction of pumping stations in Syria in November, 1956, production in Iraq in 1957 was considerably reduced. Iraq Petroleum Co., et al paid the government $137 million in 1957 compared with $193 million in 1956.

The three companies operating in Iraq — Iraq Petroleum, Basrah Petroleum, and Mosul Petroleum — drilled 8 oil wells and 2 gas wells in 1957. Two wells were for information and 4 were dry. Seven rigs are running for the three companies. Mosul Petroleum drilled one well to 12,610 ft before abandoning it. No new fields were found last year.

During the year an 18-mile 16-in. pipeline was laid parallel to the existing 12¾-in. Rumaila to Zubair line. It is connected into the main Zubair-to-Sao pipeline system.

The government-owned lubricant plant was completed at a cost of $11 million at the Dourah refinery near Baghdad. An asphalt unit was also built at the plant. The government has a project for another refinery at Qaiyyara in the north.

IRELAND

Caltex, Esso, Shell-Mex, and BP have begun constructing a new $34 million oil refinery at Whitegay Bay, County Cork (South). The plant will help fill local demand for petroleum products, which runs about 40,000 b/d. Capacity of the new plant will be about 32,000 b/d.

A marine terminal is to be built off Corkbeg Island where tankers can bring the crude.

ISRAEL

Prod. 1600 b/d — **R. C. 85,000 b/d**, **Runs 26,000 b/d**

Oil products consumption in Israel ran about 32,000 b/d in 1957, costing some $55 million in imported oil. About 1600 b/d are being produced at the Heletz/Brur field.

Drilling activity slowed down during the second half of 1957. The number of drilling rigs in operation dropped to 4 from a previous high of 12. Geophysical (seismic) work increased; 17 party-months of seismic work were carried out during 1957.

Formation of a national, government-sponsored, Israel oil company is under way. The company is expected to start exploration on about 9 new licenses in all parts of the country.

Ten groups of private oil companies (seven foreign companies and three Israeli companies with foreign capital participation) have been granted 34 oil licenses, on the basis of the 1952 petroleum law. At the beginning of 1957, oil companies and drilling contractors operating in Israel were exempted from payment of sales and excise taxes on locally produced materials, as well as from customs duties on imports.

During the period in which the Suez Canal was impassable, the government built a 140-mile 8-in. pipeline from Eilat on the Gulf of Aqaba to Beersheba, and later extended it by means of a 16-in. section to Ashdod Yam on the Mediterranean. Oil has been going from there by tanker to the Haifa refinery. The 16-in. line is now being extended to Haifa.

ITALY
(Also see Sicily and Trieste)

Prod. 2900 b/d — **R. C. 487,000 b/d**
Gas 484 m²cf/d — **Ref. 400,000 b/d**

ENI, the state company in Italy, has a virtual monopoly of exploration covering almost the whole of the Po Valley. The oil law of Italy is unsatisfactory to outside capital. There has been some indication of future changes, but that will await parliamentary decision.

One of the new concessions made by the Italian government is that they exempt from customs, machinery and equipment when used in exploration and production of hydrocarbons.

Early in 1957 Gulf Oil withdrew because of the uninviting terms of the new law.

Some geological work was completed during 1957 by Adriatic Petroleum Corp. (Cities Service), which has exploration permits in southeastern Italy.

Refining runs are approximately 400,000 b/d. More capacity is planned. The Italian company Purfina Italiana (ENI and Petrofina) is building a 30,000 b/d refinery near Rome. Purfina will shut down its 11,000 b/d plant there.

ENI transferred a 1700 b/d refinery from Nobara, northern Italy, to Gela, Sicily, to process new output there.

Italy is another country that has officially asked its refining companies to bring up their stocks of crude oil and products to 25 percent of the annual capacity of their refineries.

Reserves of natural gas were recently estimated at 4767 billion cu ft. ENI has done well with its natural gas operations.

JAMAICA

After a $3 million program of exploration and drilling, Pan Jamaican Oil Company (Pan American Petroleum Corp.— Standard of Indiana) has relinquished its concessions in this island. The company had prospecting licenses on the land area and some offshore. No other company has begun operations here.

JAPAN

Prod. 5870 b/d — **R. C. 489,900 b/d**
Gas 24,178 mcf/d — **Runs 273,500 b/d**

Consumption of petroleum in this island country is growing rapidly, reaching 264,658 b/d in 1957. Nearly all had to be met by imports, mostly crude oil because of the country's large refining capacity. Imported were 255,500 b/d of crude, and 58,642 b/d of products; 8605 b/d products are exported.

Intensity of the Japanese search for oil carried on by Japan Petroleum Exploration Co., Tokyo, is indicated by the 42 rigs that drilled 185 wells in 1957; 136 were producers. There are 87 geological and 39 geophysical crews operating.

Reserves now have reached more than 21 million bbl of oil and more than 7 trillion cu ft of gas.

Japan Petroleum (Japex is 56.5% Japanese Government) has a contract with R. G. LeTourneau to manufacture the country's first offshore drilling platform. Part of the work will be done by a Japanese shipyard.

Refinery capacity continues to expand. Most of these companies are combines of international oil companies with Japanese companies in which each holds about half the capital. Three new refineries were under construction in 1957: a 30,000 b/d plant of Idemitsu at Pokuyama; Nippon Oil's 9000 b/d refinery at Muroran, a 40,000 b/d refinery at Yokkaichi of Showa, Shell, and Mitsubishi. Capacity of Daikyo's plant at Yokkaichi will be more than

doubled — 50,000 b/d — when additions are completed this year. In the planning stage are a number of other new refineries.

The Toa Nenryo Kogyo KK (partner of Stanvac) is expanding its 7000 b/d refinery at Shimizu to 34,000 b/d. Mitsubishi is enlarging its Kawasaki refinery by 25,000 b/d to 51,500 b/d.

JAVA (Indonesia) (See Indonesia)

Prod. 7300 b/d **R. C. 7800 b/d**
Runs 6600 b/d

Shell's two small fields are declining. Each field has small plant for processing.

JORDAN

Despite its political trouble, Jordan has seen increased interest in its oil potential. In 1955 Edwin G. Pauley acquired a concession over ⅓ the country's 37,000 sq miles. The concession ran for six years, may be extended to 10, and payment is $50,000 a year for the first three years, $100,000 a year during each subsequent year. Pauley has drilled at Meshash and at Ramallah.

If oil is found profits will be shared with the Jordan government on a 50-50 basis. The U. S. Government's International Cooperative Administration has guaranteed the investment against expropriation for a period of 20 years. This was the first ICA contract ever made to protect a U. S. investment abroad in oil operations.

Phillips has acquired a half interest in a 7,700,000-acre oil and gas concession covering about ⅓ the area of Jordan. An exploratory well, the first ever drilled in Jordan, was not commercially successful. A second well has been spudded in approximately 12 miles north of Jerusalem.

The last ⅓ of the country is covered by a concession awarded George Zimairi, an Arab living in Guatemala. His contract with the government is similar to Pauley's except that his concession payments are slightly higher during the exploration period.

Jordan's consumption runs around 3000 b/d which, though small, is rising steadily. The country obtains its supplies from the Tripoli and Sidon refineries in Lebanon, but they are looking forward to building a plant at Zerqa, northeast of Amman and south of Tapline, from which crude supplies could be taken. The Dutch firm Comprimo is working on preliminary specifications.

KENYA

BP-Shell Exploration Co. has renewed its exploration license over the coastal part of Kenya south of the equator, but no active work is being carried out at present.

Frobisher Co., a Canadian firm, has taken out an oil exploration license over northeast Kenya east of 40° 30'E and north of 2°N. It is expected that field work will begin shortly.

KOREA

Oil prospecting has recently started, for the first time, in Northern Korea. Area under study is near Aoji, close to the Korean border with Manchuria and the USSR.

There are no production or refinery operations in South Korea. All petroleum products are imported. The largest industrial project utilizing imported fuel oil will be a urea fertilizer plant built by McGraw-Hydrocarbon for the Republic of Korea Government, with funds from the U. S. Government International Cooperation Administration.

KUWAIT

Prod. 1,139,850 b/d **R. C. 30,000 b/d**
Runs 27,307 b/d

Despite restrictions on production and exports of crude oil imposed by the blockage of the Suez Canal during the first four months of the year, output was higher than in 1956 by approximately 4%.

Kuwait Oil Co. (BP and Gulf 50-50) had 9 drilling rigs in operation at the end of the year, one of which was a completion rig and another engaged on workover repairs. Forty-eight development wells in Southeast Kuwait and one exploration well in North Kuwait were completed in 1957, all as potential producing wells.

Development drilling of Raudhatain field, in North Kuwait, commenced late in the year with 3 rigs, 2 of them operated by contractors. The wells are being drilled to total depth with heavy duty rigs and completed for production with a 'National 50' rig. A further heavy duty rig was engaged on exploration drilling on other structures in North Kuwait.

In addition to the 11 gathering centers now in operation in Southeast Kuwait, two more centers are under construction in the Burgan field. No production facilities exist at present in North Kuwait, but work commenced on laying the first stage of the 30-34-in. transit line which will eventually run from a new tank farm north of Ahmadi 11½ miles to Raudhatain. Being erected are 262,800-bbl tanks at new North Ahmadi Tank Farm.

To handle the crude oil exports from this extra storage, work commenced in the latter part of 1957 on the construction of a new oil loading pier some four miles north of the present pier at Mina al Ahmadi. Berth capacity of this pier will be for 5 tankers of varying sizes up to 65,000 tons simultaneously, but tankers of 100,000 tons or over will be accommodated when vessels of this size come into service.

Exports average 1,110,221 b/d in 1957 to 18 countries.

Work on the expansion of the refinery at Mina al Ahmadi was almost completed by the end of 1957. The first new 80,000 b/d distillation unit was scheduled to come on stream early in January and the second early in February and these increase throughput capacity from 30,000 to 190,000 b/d. The bitumen plant has an input capacity of 500 b/d and average 238 b/d output.

KUWAIT (Neutral Zone)

Prod. 62,200 b/d

Production almost doubled in the Wafra field in 1957. All production is from three different zones in the field. Present production belongs to American Independent Oil Co., and Getty Oil Co. The former includes 11 U.S. firms.

American Independent has under way a sizable program for the expansion of oil handling and storage facilities.

A second 12-in. pipeline, extending from the Wafra gathering center to the oil shipping terminal at Mena Abdulla, was built and four 1000-hp engines coupled to centrifugal pumps were installed.

At the gathering center, considerable tankage has been added, desalting capacity tripled and other treating equipment installed. Principal expansion is concentrated at the terminal, with 855,000 bbl of storage tankage built or building, a 30,000 b/d refinery and two new submarine loading lines under construction.

A Japanese group negotiated with Saudi Arabia and Kuwait for offshore oil concession rights beyond the 6-mile territorial waters off this territory. (Kuwait agreed to the terms in May, 1958. The company will pay 57% royalties and taxes. The neutral zone is owned 50-50 by Saudi Arabia, which had already signed the agreement, and Kuwait.)

LEBANON

R. C. 23,300 b/d
Runs 18,000 b/d

Only two refineries are here — Iraq Petroleum has a 11,500 b/d plant at Tripoli and Mediterranean Refining Company (Caltex 50%) operates a 11,800 b/d plant at Sidon.

Lebanon is crossed by IPC's two pipelines and Tapline (Aramco). These pipelines provide steady income for the government.

Total export of oil from the IPC terminal at Tripoli during 1957 was 2,874,000 tons in 188 tankers. Pumping to the Mediterranean was not resumed until March 11, 1957. It had stopped in November, 1956 after the pumping stations in Syria had been destroyed.

LIBERIA

Exploration has been carried out on a concession here held jointly by Texas Gulf Producing and W. R. Grace Co.

LIBYA

Discoveries by the French in Algeria, and particularly the Edjele field development adjacent to the Libyan border, has brought about active exploration by the several companies holding concessions in Zone IV (Fezzan) and Zone I (Tripolitania).

An important oil discovery was made by Esso Standard in its Atshan No. 2, in Concession 1, Zone IV. Atshan No. 1 found gas and the third test, early this year, was dry.

Drilling activity at year end may be summarized as follows:

D'Arcy Exploration (Africa) Ltd. was drilling its Castel Benito No. 1 in Zone I about 30 miles south of Tripoli, in Concession 34.

Mobil Oil of Canada Ltd. was drilling El Gattar No. 1, also in Zone I, about 186 miles southeast of Sirte in Concession 57.

Oasis Oil Co. (Ohio Oil) was preparing to drill at Bahi No. 1 in Concession 32 of Zone I, about 108 miles southeast of Sirte. The 62 million-acre concession is held by Ohio, Conoco and Amerada.

Libyan American (Texas Gulf Producing) was drilling its Farzugha No. 1 in Concession 18 of Zone II, about 50 miles northeast of Bengazi.

Shell completed a seismic survey in Fezzan province.

There has been a considerable increase in concession holdings in Zones I and IV (Tripolitania and Fezzan). D'Arcy, Caltex and Gulf Oil of Libya have received concession grants in these areas as also have Nelson Bunker Hunt and Ed Pauley. Several of these companies have entered into contracts with drilling contractors for testing the concessions.

Compagnie Francaise des Petroles has been granted its fourth exploration concession in Libya. The new concession is adjacent to one of its existing concessions and lies northeast of the new Edjele oilfield (CREPS) in the Algerian Sahara. The area in Libya immediately adjacent to the concession area in which Edjele lies is held by Esso-Standard.

Concessions totalling about 36,000 sq miles have been awarded to Pan American (Standard of Indiana). The concessions comprise one tract in Zone II and two in Zone IV.

This rash of exploration began around the latter part of 1955 after Libya's

new and liberal petroleum law went into effect. A further acceleration of drilling activity is expected in Libya.

MADAGASCAR

Societe des Petroles de Madagascar (APM) in 1957 had 7 geological crews and 11 geophysical crews in the field. The 2 rigs operating drilled 4 wells, all dry. The French company is making every effort to map out the oil possibilities in this island off the African east coast.

MALTA

An oil prospecting contract was concluded between the Government of Malta and BP Exploration Co. The contract calls for the company to spend some $12½ million within three years and to begin drilling in 1958. The concession covers a period of 25 years, subject to renewal for a further period of 10 years.

MANCHURIA

Exploration activities being carried out in northern Korea near Manchuria indicate that there has been some success in developing the small oil deposits the Japanese found when they were in occupation there.

MEXICO

Prod. 253,000 b/d **R. C. 322,000 b/d**
Gas 350 m cf/d **Runs 228,000 b/d**

In the 20th anniversary since the Mexican oil industry was nationalized Sr. Antonio Bermudez, director general of Pemex, issued a report that went back to Pemex's organization. Our information, however, comes not directly from that but from a letter to the Wall Street Journal from Bermudez. An article in the Wall Street Journal cast some doubt on the success of Pemex and these figures are contained in Bermudez's reply:

"Exploration: In 1938 there were four exploration teams in the field. In 1958 there were 44 teams. During 1957 these teams discovered 14 new fields.

"Drilling: When Pemex began operations there were 16 rigs in all Mexico. Pemex now maintains 160.

"Reserves: In 1938 the most optimistic estimates by private oil companies placed reserves at 835 million bbl. Reserves are now conservatively estimated at 3373 million bbl, and in the interim 1220 million bbl have been produced.

"Production: Average daily oil and distillate production during the year of nationalization (the peak production was 17 years before) was 106,000 b/d. It is now 272,000 b/d. (Does not include gas.)

"Refining: In 1938 capacity for refining was 102,000 b/d. It is now 322,000 b/d."

Despite this record over the 20 years, it must be pointed out that crude oil production gained only 1½% in 1956 and dropped 2%, to 88.7 million in 1957. Wells drilled in 1957 were 308 compared to 402 in 1956.

Demand in Mexico for oil products is running high. Oil imports exceed value of the exports to an exchange disadvantage and in 1957, in terms of volume Mexico was a net importer, for the first time. Consumption ran 243,500 b/d.

The Minatitlan refinery is being enlarged and the 10-in. product pipeline across the Isthmus of Tehuantetek from the refinery to the Pacific Coast port of Salina Cruz is being enlarged. A 22-in. gas line from Reynosa to Monterrey was constructed. Gas began flowing into the U. S. in August 1957, reaching 142 m cf/d at the end of the year.

Prices of oil products are held down by the government; oil consumers in Mexico have been accustomed to these low prices. Not only that, but the labor force has grown to 40,000 individuals and expenses are high. Chief problem of Pemex then, is to create capital for development. Recently the Government of Mexico authorized an issue of about $16 million to be invested in Pemex, but this is hardly sufficient to meet capital demands for the biggest industry in Mexico.

MOROCCO

Prod. 1435 b/d **R. C. 7500 b/d**
Gas 362 mcf/d **Runs 7000 b/d**

Societe Cherifienne Des Petroles drilled 19 wells in 1957, of which 6 are producing. This brings the number of producing wells in the country up to 96. Two geophysical and one geological crews were operating. Reserves at this time are estimated at more than 10 million bbl of oil and 424 million cu ft of gas.

Morocco had an agreement in 1957 with USSR for about 375,000 bbl of crude oil to be treated in the Petitjean refinery.

MOZAMBIQUE

Only exploration operations in Mozambique during 1957 were carried out by Mozambique Gulf Oil. One rig was in operation during the first half of the year completing two exploratory wells — Temane No. 1, TD 11,500 ft, and Mambone No. 1, TD 11,848 ft. Preparations were under way at year end for a resumption of geological-geophysical surveys of the recently acquired north extension to the original concession.

NETHERLANDS

Prod. 29,075 b/d **R. C. 343,000 b/d**
Runs 332,000 b/d

Biggest project in the Netherlands is building a 100,000 b/d refinery by Esso Netherlands N. V. at Rotterdam in the Botlek area. Plans were launched in 1957 but the refinery will not be on stream until 1960. Badger Manufacturing Co.'s subsidiary is doing the mechanical engineering and field construction, after the process design by Esso Research and Engineering.

The two refineries now operating in Holland are both near Rotterdam. BPM refinery, with 300,000 b/d is the largest in Europe. A rubber plant is being added to this Royal Dutch Shell refinery.

Caltex is to build a new 50,000 b/d refinery in the Botlek area, also near Rotterdam. It will be linked by a pipeline to the present 46,000 b/d refinery at Pernis.

At its Pernis refinery BPM is constructing a 12,700 b/d catalytic reformer, a hydrodesulphurizer, 16,400 b/d; a second hydrodesulphurizer, 7800 b/d; and an alkylation plant, 2800 b/d, all of which will be completed this year.

During 1957 N. V. Nederlandse Aardolie Mij (Shell and Jersey) the only oil company engaged in searching for oil in the Netherlands, continued its program of exploration and increased its production in all its newer fields.

Consumption in the Netherlands has risen 86% in the last 5 years. In 1957 consumption ran 102,000 b/d.

Plans were made in 1957 and agreed upon in 1958 for a 24-in., 187-mile crude oil pipeline to be laid from Rotterdam to the German Rhineland refineries at Godorf and Weseling. Name of the company is N. V. Rotterdam-Rijn Pijpleiding Mij (Shell 40%, Caltex 40%, Gelsenberg and Mobil Oil 20%).

NETHERLANDS ANTILLES

R. C. 650,000 b/d
Runs 620,000 b/d

Aruba. Lago Oil and Transportation Co. (Jersey Standard) averaged a throughput of 412,000 b/d at its 440,000 b/d plant.

Curacao. Royal Dutch Shell completed its 33,000 b/d catalytic cracker at its 210,000 b/d capacity plant here. Refinery runs for 1956 were 289,000 b/d, but this includes the crude intake to cracking plants.

NEW CALEDONIA (French)

Societe de Recherches et d'Exploitation de Petrole (SREP NC) in New Caledonia during 1957 had one geological crew and two marine geophysical crews in the field. This French island is east of Australia.

NEW GUINEA (Netherlands)

Prod. 6452 b/d

The three small fields of Netherlands New Guinea Petroleum Co. continue to decline.

NEW ZEALAND

Prod. 15 b/d **R. C. 80 b/d**

Consumption is the biggest thing about New Zealand's oil industry. It runs about 26-27,000 b/d. Some exploration is carried out by Shell, BP and Todd interests. Shell handles the operations. These three are carrying out an exploration program over about 5500 sq miles, which is estimated will cost some $3 million.

The small new Plymouth field continues to produce some oil.

One new effort to obtain domestic production is in the Nevis district of New Zealand, where oil shale is found in large quantities.

An automatic plant to make town gas from residual fuel oil was built at Hastings. It has a capacity of 300 mcf/d. It is completely automatic, requiring only one operator.

NICARAGUA

A well is being drilled in shallow water 25 miles off Puerto Cabezas, on the Caribbean coast of Nicaragua, by J. Ray McDermott and Co. of Houston, Weatherford Oil Co., and Warren Petroleum Corp. The three companies jointly hold an 11 million-acre concession covering both land and offshore areas of the Caribbean coast.

Imports into this Central American country for consumption average about 3000 b/d, mostly from the Netherlands West Indies.

NIGERIA

Prod. 3100 b/d*

After 21 years and some $75 million the first cargo of crude oil was exported from this West African territory. It was routed for Rotterdam, the Netherlands, to be used at Shell's Pernis refinery. Shell-BP Development Co. of Nigeria, only operator here, has two oil fields — one at Oloibiri in the swamp and mud of the Niger Delta, and the other at Afam in the bush country. Some exploration has been done over about 40,000 sq miles and 19 tests have been drilled. A third oil-bearing region was found at Soku.

Oil from the Afam field is being pumped through a 6-in. pipeline to Port Harcourt at the rate of 2500 b/d. Production from the Oloibiri field is limited to 600 b/d until a 10-in. pipeline from there to Port Harcourt is completed in 1958.

Shell-BP at present has 5 drilling strings and 7 seismic parties in operation. $28 million is earmarked for 1958. Drilling outfits are expected to be increased to 9, and 2 drilling barges will be added for operations in the swamps.

Mobil Exploration Nigeria has been

*At end of year.

awarded a concession covering 4000 sq miles in the coastal zone of the western region.

NORWAY

R. C. 2000 b/d
Runs 1800 b/d

An agreement has been approved between the Norwegian Government and Jersey Standard for construction of the country's first major refinery. It will be built on the Oslo Fjord, beginning this year and will be designed to process about 40,000 b/d of Mideast crude. Cost is estimate at $29 million.

Consumption in Norway runs around 60,000 b/d and the new refinery will go a long way toward satisfying domestic demand.

OMAN-MUSCAT (and Dhofar)

Said bin Taimur, Sultan of Muscat and Oman (owns Dhofar) had some political troubles in 1957. The British were pledged to help the Sultan and it was a little hard to decide who was supplying the initiative for the rebels fighting him.

Part of the trouble sprang from the fact that Cities Service and Richfield (50-50 in a 32,000 sq. mile concession) had discovered the first oil in Dhofar, on the coast of Arabia, 35 miles inland from the Arabian Sea. After two unsuccessful attempts to find oil, the discovery Marmul tested 2000 b/d of 22 gravity oil at 3200 ft. Nearest oil production to Marmul is in Saudi Arabia, nearly 600 miles away.

The first well drilled had substantial oil shows. A heavy rig is now testing one of these prospects while a lighter rig is developing the Marmul structure.

Geological and geophysical work is carried on by 2 geological field parties, a seismic crew and a gravimetric party.

Petroleum Development (Oman) an associate of Iraq Petroleum Co., holds the concession in Oman and Muscat (to the north.) It once held a concession in Dhofar before the Cities Service-Richfield group obtained it.

PAKISTAN

Prod. 6000 b/d **R. C. 6000 b/d**
Gas 36,700 mcf/d‡ **Runs 5950 d/b**

The Government of Pakistan has asked Burmah Oil, Shell, Caltex, and Stanvac to submit proposals for setting up an oil refinery in the country. The four companies are studying the project. The only refinery is a small one belonging to Attock in northern Punjab.

Consumption in Pakistan runs some 40,300 b/d, of which all but 6000 b/d is imported in products.

West Pakistan. Tidewater, Skelly and Kewanee (each ⅓) early in 1958 signed a concession agreement with the Government to explore two areas totalling 10,000 sq miles in West Pakistan, with Tidewater as operator. This follows the same type of agreement now in force with Stanvac, H. L. Hunt, and Sun. The government shares exploratory and development expenses up to 25% and will be entitled to 25% of any oil found. Profits will be shared 50-50.

Hunt is said to have spent about $3 million searching for oil in Pakistan and Pakistan Petroleum (Burmah Oil 70%—Pakistan 30%) spent more than $4½ million in both parts of Pakistan in 1957.

The Caltex group is also negotiating for exploration rights.

Pakistan Petroleum was drilling at the end of the year near Sibi. Two wells at Khairpur 2 were drilled and abandoned, one at 11,670 ft.

Adhi 1, a joint Pakistan Petroleum-Pakistan Oilfields well, was abandoned at 2098 ft. Adhi 2 was spudded in during November.

In the Punjab, Pakistan Petroleum produced an average of 1312 b/d during 1957 from the Balkassar field, operated jointly with Attock.

Pakistan Oilfields brought Karsal 1 to production from 11,796-893 ft. An agreement has been made with Pakistan Petroleum for joint testing of Karsal and Pira Jangla concessions, and the second well was drilled to 4811 ft by the end of the year, the location being based on results of a seismic reflection survey.

Total raw gas offtake during the year from Pakistan Petroleum's Sui field was 11,838 mcf. Sales of gas increased slowly and in December production of raw gas averaged 36,700 mcf/d.

Laying a 217-mile, 16-in. pipeline from Sui gas field in West Pakistan to Multan was completed in 1957. The gas carried by this line will be used in a government fertilizer factory built by ENSA, a French group, at a cost of about $34 million.

East Pakistan. Pakistan Petroleum's Sylhet 3 was completed at 5497 ft with gas from about 4000 ft. Reserves are estimated at about 200 billion cu ft. The government will build a fertilizer plant to use the gas. Kobe Steel Works of Japan has the contract to build the $32 million plant.

‡At end of 1957.

PANAMA

One of two refineries contracted for this country is now being built. This is the 55,000 b/d plant of Panama Refining and Petrochemical Co. (John W. Shaheen and Eugene DuPont) at Colon. Foster-Wheeler is the prime contractor. The other plant, of the same capacity, will be built at Los Minas Bay.

Exploration is pursued diligently with some 13-15 field parties active.

Champlin Oil and Refining was granted a 870,000-acre concession in Chiriqui province and shipped a rig there to begin drilling this year. Champlin has two partners in the venture — Kerr-McGee and Southland Royalty of Fort Worth. United Fruit Co. acquired a million-acre concession in the same province; Eastern States Petroleum and Chemical Corp. have a new 1⅓ million acre concession; and Delhi-Taylor was granted a 1½ million-acre concession in Darien province near the Colombian border.

Cataract Mining, which has a 2 million-acre concession in Chiriqui province, signed an agreement with a local company to explore 52,000 acres. Consolidated American Industries has a 2-million-acre concession in Darien. Concessions are also held by Union Oil and California Standard.

Esso Standard drilled 5 dry holes in Panama and other Central American countries last year, with 3 rigs operating.

PAPUA (New Guinea)

The Australian territory of Papua (southeast side of New Guinea Island) has taken some $66 million in about 20 years with only some oil shows and some good gas encounters to tempt the interests that have carried on the expensive search.

Australasian Petroleum Co. and Island Exploration (both BP, Stanvac, and Oil Search) need about $12 million more for the program they have mapped out. Four rigs are in the country and 3 dry holes were drilled last year. The main reason these wells are so expensive is the difficult communications and climatic conditions. Of the 3 completed during 1957 the deepest was 7305 ft, the shallowest 1510 ft.

PARAGUAY

Early in 1958 International Products Corp. signed an agreement with Rimrock Tidelands for the two companies to share in development of a 7½-million-acre oil concession granted in 1957 by Paraguay. Rimrock is an affiliate of Husky Oil, Wyoming.

A number of concessions were awarded by the Paraguayan Government in 1957. Pure Oil was granted a 14.8 million-acre concession in the Chaco region, bordering on Bolivia and Argentina. Associates are Williams Bros., Gulf, Sinclair and Tidewater.

Standard Oil of California applied for a concession in October. A Brazilian concern, Companhia Petrolera Guarani S. A., was granted a 10 million-acre concession in the Chaco region.

It has been 10 years since Union Oil of California held a concession in this area. The company drilled 5 dry holes and spent a total of $7½ million before it forfeited its rights.

The country has no refining capacity and imports about 1700 b/d to meet consumption.

The government continued to press its plans for a Trans-Chaco pipeline to bring Bolivian crude oil to the Paraguay River, where it is proposed to build a new refinery.

PERU*

Prod. 53,000 b/d **R. C. 47,200 b/d**
Runs 43,100 b/d

Perhaps the most outstanding move in 1957 in Peru was that International (Jersey Standard) and Lobitos Oilfields made an agreement whereby International acquired a half interest in a concession of Lobitos for $18 million. International will be the operating company and plans to do an extensive development program in the northeast corner of the country, where the concession lies.

Interesting exploration work is being carried on in the Oriente region where the first new field was found since Ganso Azul was discovered nearly 20 years ago. The new field is the result of a search by a German combine and Peruvian "El Oriente" company. Three producing wells were brought in during 1957 and two tests were abandoned. Also in the Oriente Texaco is drilling its fourth wildcat along the Maranon River, Peruvian Gulf Oil, which carried out field geographical studies in 1957 and as a result of this and the evaluation of airborne magnetometer data by Fairchild, has retained some 1.7 million acres of its eastern concessions. Peruvian Pacific and Richfield continue their joint exploration program in the Oriente. An airborne magnetometer survey was undertaken for them in 1957. They have a geological field party and a seismic crew working in the area. All together 33 million acres are covered by concessions held by 16 companies. Of the 147 wells drilled, 128 were oil producers.

Sixteen rigs were active in the country. A number of operators have reduced their holdings in the Sechura desert, which was a popular drilling spot until 20 some dry holes were drilled.

*Details of operation in this country can be found in the Peruvian issue of The Petroleum Engineer, April, 1958.

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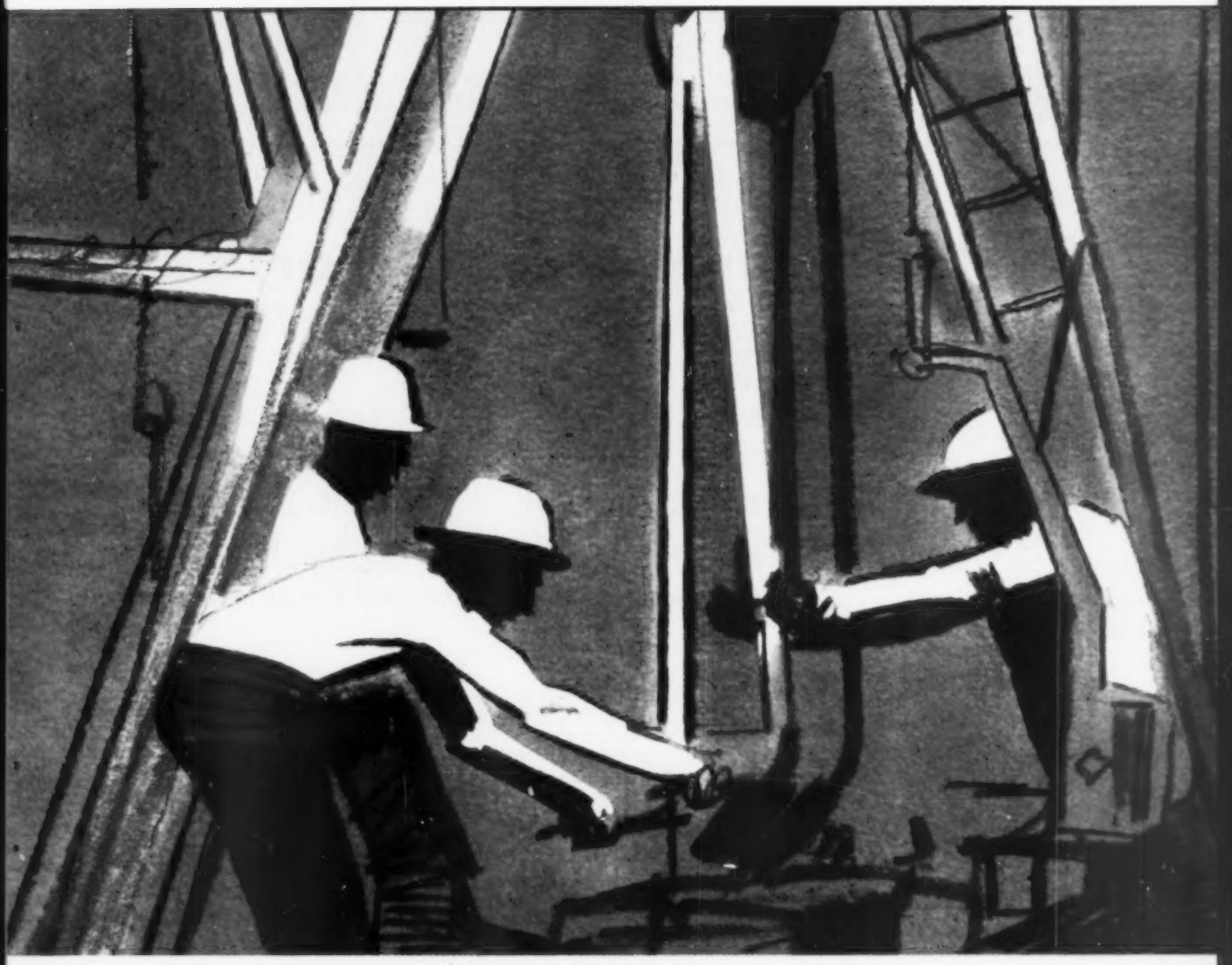
Balance of this review will be published in the July 15 issue.



Sign of Water....Layne

Vital to most petroleum operations is a guaranteed supply of water. Water for removing heat loads, process consumption and accompanying plant operations—all require determined amounts for an hour, a day, a year—indefinitely. That's why the well site must be accurately determined and the well constructed to deliver the available water.

Layne wells circle the globe. Every condition and every problem possible has been met and solved. This know-how and over three quarters of a century of experience result in efficient, economical wells—the basis of many industrial water systems. Layne drilled wells provide a reliable water source—the criterion for industrial water supply.

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CATERPILLAR

Pushing through the world's longest pipeline

With 35 Caterpillar-built units in its spread, Majestic Contractors, Ltd., has laid 34-inch at a pace usually reserved for smaller pipe

Seven Cat No. 583 Pipelayers are helping Majestic Contractors, Ltd., lay 1½ miles of 34-inch pipe a day on the Trans-Canada pipeline.

No. 12 Motor Grader and two D7s are used on backfilling operations. The spread includes 35 pieces of Caterpillar equipment—engines, pipelayers, tractors and motor graders.

A Cat D339 Diesel powers this Cleveland ditcher in Saskatchewan. There are nine rugged, heavy-duty Caterpillar Engines at work in the spread.

When finished, the Trans-Canada pipeline will be the longest in the world. It will slash 2,500 miles across Canada, bringing Alberta gas as far east as Montreal.

Majestic Contractors, Ltd., of Edmonton, Alberta, is laying a 100-mile section of the pipe from Burstall to Leinan, Saskatchewan. It is putting the 34-inch pipe into the ground at an average rate of 8,700 feet per day. This equals the rate that smaller big-inch pipe is being laid elsewhere in the industry. In one record 10-hour working day, Majestic welded 305 joints of 40-foot-length pipe.

Spread No. 1, which is setting this pace, is practically all Caterpillar. It includes seven new CAT* No. 583 Pipelayers, the highest capacity machines in the industry; five MD7 Pipelayers; seven D7s; three D6s; two D4s; one D2, and a No. 12 Motor Grader. And Majestic is relying on nine rugged, heavy-duty Caterpillar Engines to power other equipment. There are seven D318s, one on a Cleveland backfiller and six on Bucyrus Erie shovels. In addition, there are two D339 Diesels on Cleveland ditchers.

Right-of-way is 65 feet. The ditch measures 52 inches at the bottom and 90 inches at the top. This is widened to 8 feet, 4 inches in sandy terrain. Here the No. 583 Pipelayers stay 10 to 12 feet from the 6-foot-deep ditch to lower the 150-pound-per-foot, 34-inch pipe. All pipe is being cradled in immediately following the doping and wrapping operations.

You can look for the production record on this job to become increasingly common in the industry as new No. 583s join more and more spreads. This is the highest capacity pipelayer in history, and it is establishing a new standard for a day's work. This efficient pipelayer can lift 130,000 lb. and its engine delivers 191 HP. And because of its well-balanced design, it is as safe as it is fast.

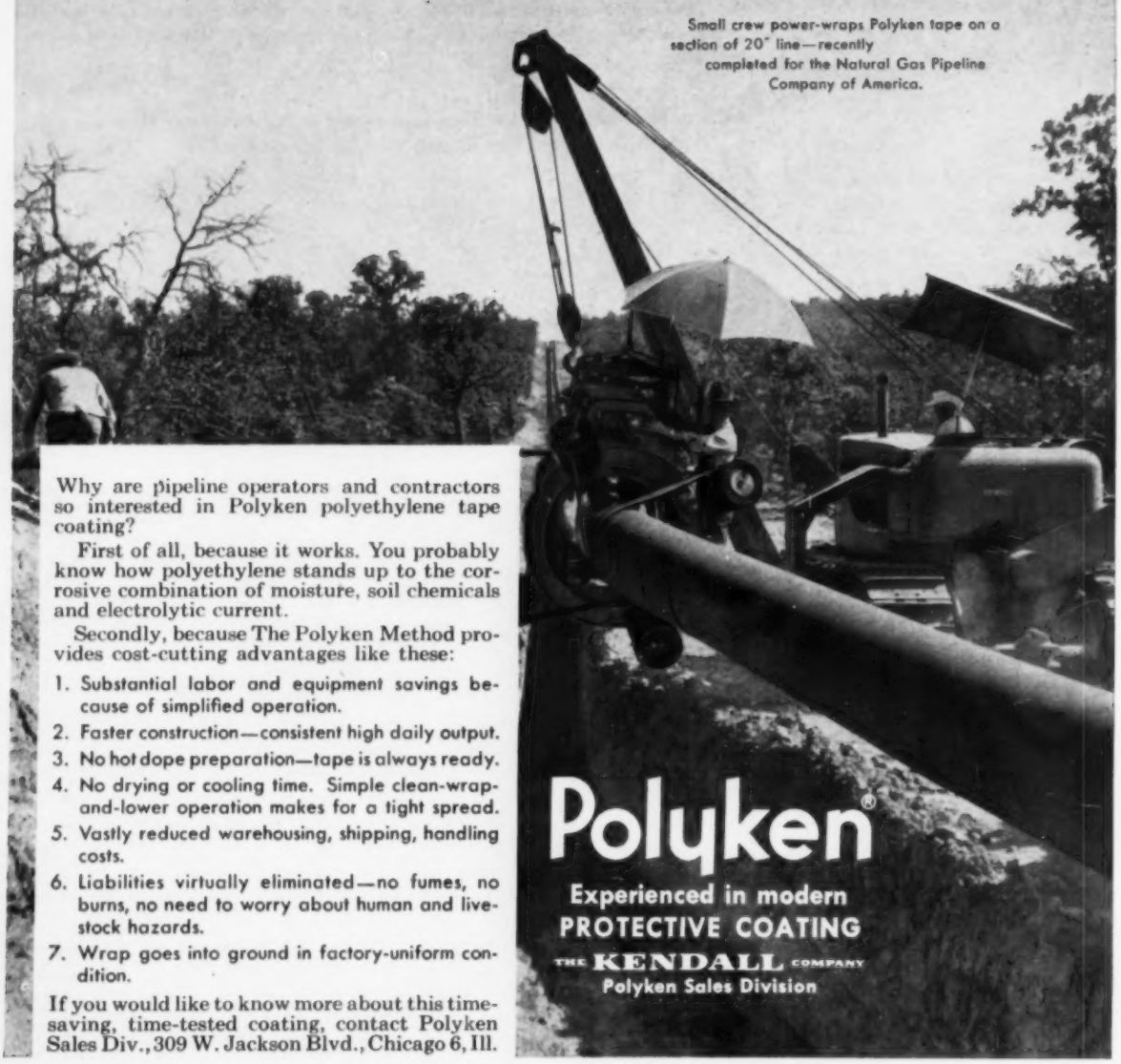
In the complete line of Caterpillar* oilfield machines and engines, there is a unit to fit every need. So call your Caterpillar Dealer soon. He will demonstrate any of his high-production machines on your job—at your convenience.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Big-Inch pipeline wrapped the modern way

Polyken Tape saves time, labor and handling costs, yet resists corrosive attack as only polyethylene can



Small crew power-wraps Polyken tape on a section of 20" line—recently completed for the Natural Gas Pipeline Company of America.

Why are pipeline operators and contractors so interested in Polyken polyethylene tape coating?

First of all, because it works. You probably know how polyethylene stands up to the corrosive combination of moisture, soil chemicals and electrolytic current.

Secondly, because The Polyken Method provides cost-cutting advantages like these:

1. Substantial labor and equipment savings because of simplified operation.
2. Faster construction—consistent high daily output.
3. No hot dope preparation—tape is always ready.
4. No drying or cooling time. Simple clean-wrap-and-lower operation makes for a tight spread.
5. Vastly reduced warehousing, shipping, handling costs.
6. Liabilities virtually eliminated—no fumes, no burns, no need to worry about human and livestock hazards.
7. Wrap goes into ground in factory-uniform condition.

If you would like to know more about this time-saving, time-tested coating, contact Polyken Sales Div., 309 W. Jackson Blvd., Chicago 6, Ill.

Polyken®

Experienced in modern PROTECTIVE COATING

THE KENDALL COMPANY
Polyken Sales Division

Here comes a good bit... and here's why

Reed Three Cone "Y" Bits are the latest developments in Reed's thirty-seven year history of designing and producing rock bits. The Reed "Y" Bit that is making hole for you today is the result of hundreds of thousands of man hours of research, engineering and technical effort spent by Reed Research and Engineering.

Reed research facilities are located in two large buildings at the Houston plant. They include complete metallurgical and chemical laboratories, mechanical testing apparatus, experimental heat treating facilities and an experimental machine shop. Laboratory drilling rigs that can apply loads of 100,000 lbs., at rotating speeds up to 500 rpm, with pump pressures to 5,000 psi, test full size bits on rock samples from all over the world.

Metallurgists, chemists, designers, engineers work as a team to develop a product that is produced to precise standards by skilled technicians in Reed's manufacturing plant. The compound benefit of *know-how* in design, development and manufacturing is a rock bit that is uniform in quality, bit after bit after bit.

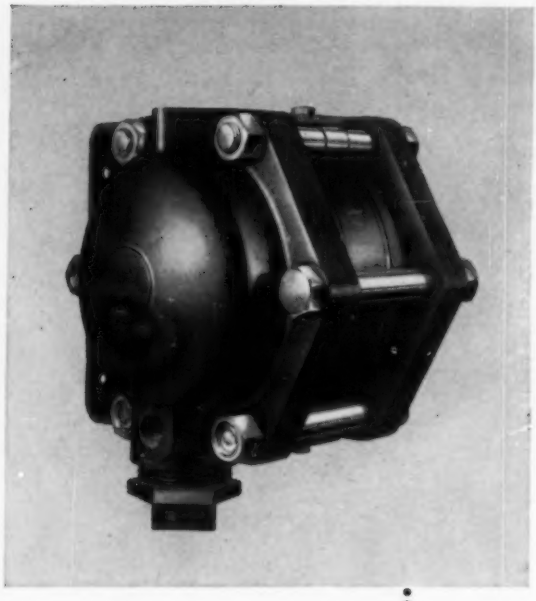
Proved in the field for four years, the Reed "Y" Bit is the bit that will *dig*. You can't run a better bit.

Reed Roller Bit Company

GULF COAST, MID-CONTINENT, ROCKY MOUNTAIN AND CANADIAN DISTRIBUTOR FOR SMITH-DRESSER PRODUCTS

Houston 1, Texas

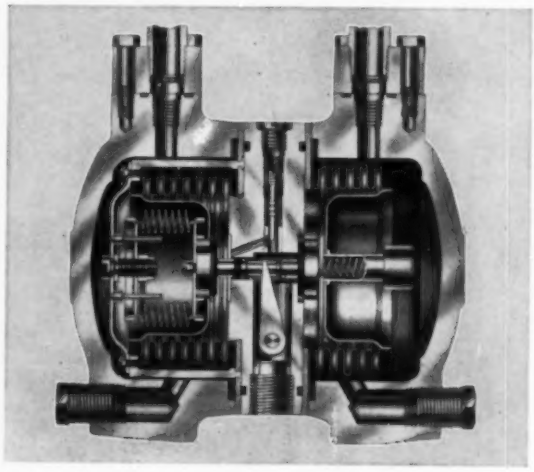
NEW!



Honeywell Bellows Meter...

unequalled for accuracy, stability, versatility in flow and liquid level metering

The new Honeywell Bellows Flow Meter gives the better performance demanded by its potential users. It's the most advanced meter body available today, with important advantages never before found in flow and liquid level meters.



Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale ... calibrated accuracy ±0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. The Honeywell Bellows Meter operates efficiently in surrounding temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field ... connections for both horizontal and vertical piping ... quick calibration and adjustment ... easy cleaning and servicing.

High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice enables essentially linear damping adjustment ... and you can adjust from outside the meter body during operation.

Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Meter by calling your nearby Honeywell field engineer today ... he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

REFERENCE DATA: Catalog C22-1

Honeywell

First in Controls

BEFORE FOA-2: This picture shows a typical instance of nozzle fouling caused by sludge.

AFTER ADDING FOA-2: Nozzles stay clean, burner operation is improved; tank contents remain free of sediment.

Du Pont FOA-2 solves sludge problem in refinery heating plant

By WILLIAM deB. BERTOLETTE

Maybe you or your customers have been forced to have fuel oil storage tanks cleaned to get rid of quantities of sludge. With proper treatment this sludge could have been dispersed and burned with the fuel.

For instance, the heating plant of a midwest refinery was using residual fuel containing 40% BS&W, with a very high solids content. Time after time, the storage tank had to be cleaned out to prevent nozzles from clogging and burners from flaming out.

Recently, following a clean-out, Du Pont's Fuel Oil Additive No. 2 (FOA-2) was added to the incoming oil stream in an effort to disperse sludge residue and stabilize the fresh oil supply.

The results were gratifying. After the additive had been used for three weeks, no sludge could be detected in the storage tank.

Effect on the burners

Examination showed the flame pattern was better, there were fewer ash deposits in the furnace, and overall burner operation was improved. (FOA-2 itself leaves no ash at all.)

The dispersing, stabilizing and solubilizing qualities of FOA-2 produced this money-saving improvement. Perhaps this instance suggests a way to improve the distillate fuel oils you sell or use yourself.

We recently published a book about FOA-2, containing all the basic information you need to consider the product. It describes composition and properties, also use concentrations, handling and addition methods, performance testing, and applications. Write us for a copy, or contact your nearest Du Pont Petroleum Chemicals sales office. E. I. DU PONT DE NEMOURS & CO. (INC.), Petroleum Chemicals Division, Wilmington 98, Delaware.

Wm. deB. BERTOLETTE, the author of this article, is technical service supervisor of the fuel oil group at Du Pont's Petroleum Laboratory. For over 20 years he has been closely associated with Du Pont's petroleum additives work.

DU PONT

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Better Things for Better Living . . . through Chemistry

Tetraethyl Lead and other Petroleum Additives

The vessels were shipped by barge through the Inland Waterway System and hauled tandem-style to the job site.

That the first time refining called for five spherical reactors in a single installation the assignment was entrusted to Wyatt's.

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Houston 1, Texas

MANUFACTURERS AND ERECTORS SINCE 1913

Now, lay coated pipe without "Special" handling

ABOVE: 16-inch pipe being spray-coated for use in new Transcontinental Gas Pipe Line Corp. gas-gathering system near Tilden, Texas.

Save up to 20 per cent in laying costs on large-diameter pipelines. Spray–coat pipe with Copon Arocoat before installation. Then, haul it, stack it, bend it and lay it with little more care than you would use for bare pipe. Tough Copon Arocoat coatings will survive these operations without chipping or cracking, and Copon Arocoat can be applied to welds with an ordinary paint brush.

A combination of epoxy and coal tar resins, Copon Arocoat coatings provide superior corrosion control. They will not deteriorate in the ground . . . remain tough and elastic . . . and are unaffected by temperature extremes. Successful applications include submerged, buried and exposed transmission lines.

Get complete information on Copon Arocoat, industry's newest weapon in the fight against rising costs of corrosion. Write today to the Copon Associate located nearest to your city.

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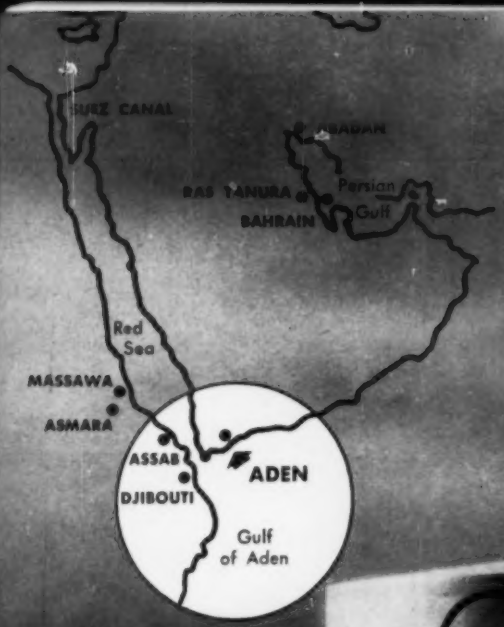
CB&I Serves Million Dollar Bunkering Terminal at historic GATEWAY TO THE FAR EAST



331,500 barrels of fuel oil and marine diesel oil are stored in four Horton® cone-roof tanks at Stanvac terminal. CB&I also installed a water storage tank, piping, manifolding, pumps, as well as loading and unloading facilities. This facility gives Aden a third bunkering terminal—to make Aden one of the world's largest and busiest ports.

Firm of Sir Bruce White, Wolf Barry & Partners, London, were engineering consultants.

Where there's petroleum and the need for petroleum storage or process equipment . . . you'll find CB&I.

Off the tip of Aden Peninsula, where Suez Canal shipping starts its voyage to the Far East, CB&I played an important role in the construction of this million dollar bunkering terminal for Stanvac.

An unusual installation yes, but a good example of how CB&I's expertly coordinated services can be made available to meet the most *specific* set of requirements. CB&I's *global representation* serves a world of petroleum with the advantage of *one* source and *one* responsibility for services including design, engineering, fabrication and erection of steel tanks and processing structures . . . for erection *anywhere*.

Write your nearest CB&I office for further details.

Chicago Bridge & Iron Company

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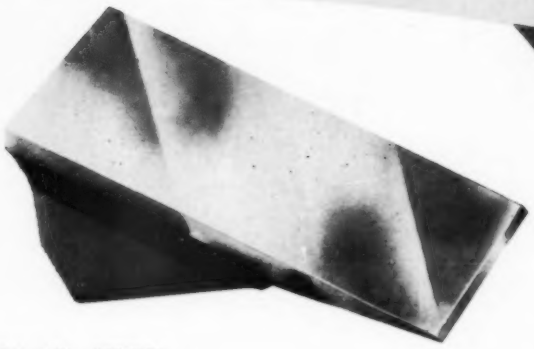
SPECIFY!

Teeth that really dig!

WHEN ORDERING
NEW EQUIPMENT



Patent No. 2807105

MAKES GOOD EQUIPMENT
DIG BETTER–LAST LONGER

H&L TOOTH COMPANY

1540 SOUTH GREENWOOD AVE. MONTEBELLO, CALIFORNIA

CONVERSION TABLE FOR MUD WEIGHTS

Specific Gravity	Weight in lb. per gal.	Weight in lb. per cu. ft.	Pressure in lb. per sq. in. per 100 ft of depth	Specific Gravity	Weight in lb. per gal.	Weight in lb. per cu. ft.	Pressure in lb. per sq. in. per 100 ft of depth
1.00	8.345	62.50	43.40	1.65	13.76	103.13	71.61
1.01	8.43	63.13	43.83	1.66	13.85	103.75	72.04
1.02	8.51	63.75	44.27	1.67	13.93	104.38	72.48
1.03	8.60	64.38	44.70	1.68	14.02	105.00	79.91
1.04	8.68	65.00	45.14	1.69	14.10	105.63	73.35
1.05	8.76	65.63	45.57	1.70	14.18	106.25	73.78
1.06	8.85	66.25	46.00	1.71	14.26	106.88	74.21
1.07	8.93	66.88	46.44	1.72	14.35	107.50	74.65
1.08	9.01	67.50	46.87	1.73	14.43	108.13	75.08
1.09	9.10	68.13	47.31	1.74	14.51	108.75	75.52
1.10	9.18	68.75	47.74	1.75	14.60	109.38	75.95
1.11	9.26	69.38	48.17	1.76	14.68	110.00	76.38
1.12	9.35	70.00	48.61	1.77	14.76	110.63	76.82
1.13	9.43	70.63	49.04	1.78	14.85	111.25	77.25
1.14	9.51	71.25	49.48	1.79	14.93	111.88	77.69
1.15	9.60	71.88	49.91	1.80	15.02	112.50	78.12
1.16	9.68	72.50	50.34	1.81	15.10	113.13	78.55
1.17	9.76	73.13	50.78	1.82	15.18	113.75	78.99
1.18	9.85	73.75	51.21	1.83	15.26	114.38	79.42
1.19	9.93	74.38	51.65	1.84	15.35	115.00	79.86
1.20	10.01	75.00	52.08	1.85	15.43	115.63	80.29
1.21	10.10	76.63	52.51	1.86	15.52	116.25	80.72
1.22	10.18	76.25	52.95	1.87	15.60	116.88	81.16
1.23	10.26	76.88	53.38	1.88	15.68	117.50	81.59
1.24	10.35	77.50	53.82	1.89	15.76	118.13	82.03
1.25	10.43	78.13	54.25	1.90	15.85	118.75	82.46
1.26	10.51	78.75	54.68	1.91	15.94	119.38	82.89
1.27	10.60	79.38	55.12	1.92	16.02	120.00	83.33
1.28	10.68	80.00	55.55	1.93	16.12	120.63	83.76
1.29	10.76	80.63	55.99	1.94	16.19	121.25	84.20
1.30	10.85	81.25	56.42	1.95	16.27	121.88	84.63
1.31	10.93	81.88	56.85	1.96	16.36	122.50	85.06
1.32	11.02	82.50	57.29	1.97	16.44	123.13	85.50
1.33	11.10	83.13	57.72	1.98	16.52	123.75	85.93
1.34	11.18	83.75	58.16	1.99	16.60	124.38	86.37
1.35	11.26	84.38	58.59	2.00	16.69	125.00	86.80
1.36	11.35	85.00	59.02	2.01	16.77	125.63	87.23
1.37	11.43	85.63	59.46	2.02	16.86	126.25	87.67
1.38	11.51	86.25	59.89	2.03	16.94	126.88	88.10
1.39	11.60	86.88	60.33	2.04	17.02	127.50	88.54
1.40	11.68	87.50	60.76	2.05	17.11	128.13	88.97
1.41	11.76	88.13	61.19	2.06	17.19	128.75	89.40
1.42	11.85	88.75	61.63	2.07	17.27	129.38	89.84
1.43	11.93	89.38	62.06	2.08	17.36	130.00	90.27
1.44	12.02	90.00	62.50	2.09	17.44	130.63	90.71
1.45	12.10	90.63	62.93	2.10	17.52	131.25	91.14
1.46	12.18	91.25	63.36	2.11	17.61	131.88	91.57
1.47	12.26	91.88	63.80	2.12	17.69	132.50	92.01
1.48	12.35	92.50	64.23	2.13	17.77	133.13	92.44
1.49	12.43	93.13	64.67	2.14	17.86	133.75	92.88
1.50	12.51	93.75	65.10	2.15	17.94	134.38	93.31
1.51	12.60	94.38	65.53	2.16	18.03	135.00	93.74
1.52	12.68	95.00	65.97	2.17	18.11	135.63	94.18
1.53	12.76	95.63	66.40	2.18	18.19	136.25	94.61
1.54	12.85	96.25	66.84	2.19	18.28	136.88	95.05
1.55	12.93	96.88	67.27	2.20	18.36	137.50	95.48
1.56	13.02	97.50	67.70	2.21	18.44	138.13	95.91
1.57	13.10	98.13	68.14	2.22	18.53	138.75	96.35
1.58	13.18	98.75	68.57	2.23	18.61	139.38	96.78
1.59	13.26	99.38	69.01	2.24	18.69	140.00	97.22
1.60	13.35	100.00	69.44	2.25	18.78	140.63	97.65
1.61	13.43	100.63	69.87	2.26	18.86	141.25	98.08
1.62	13.51	101.25	70.31	2.27	18.94	141.88	98.52
1.63	13.60	101.89	70.74	2.28	19.03	142.50	98.95
1.64	13.68	102.50	71.18	2.29	19.11	143.13	99.39
				2.30	19.19	143.75	99.82

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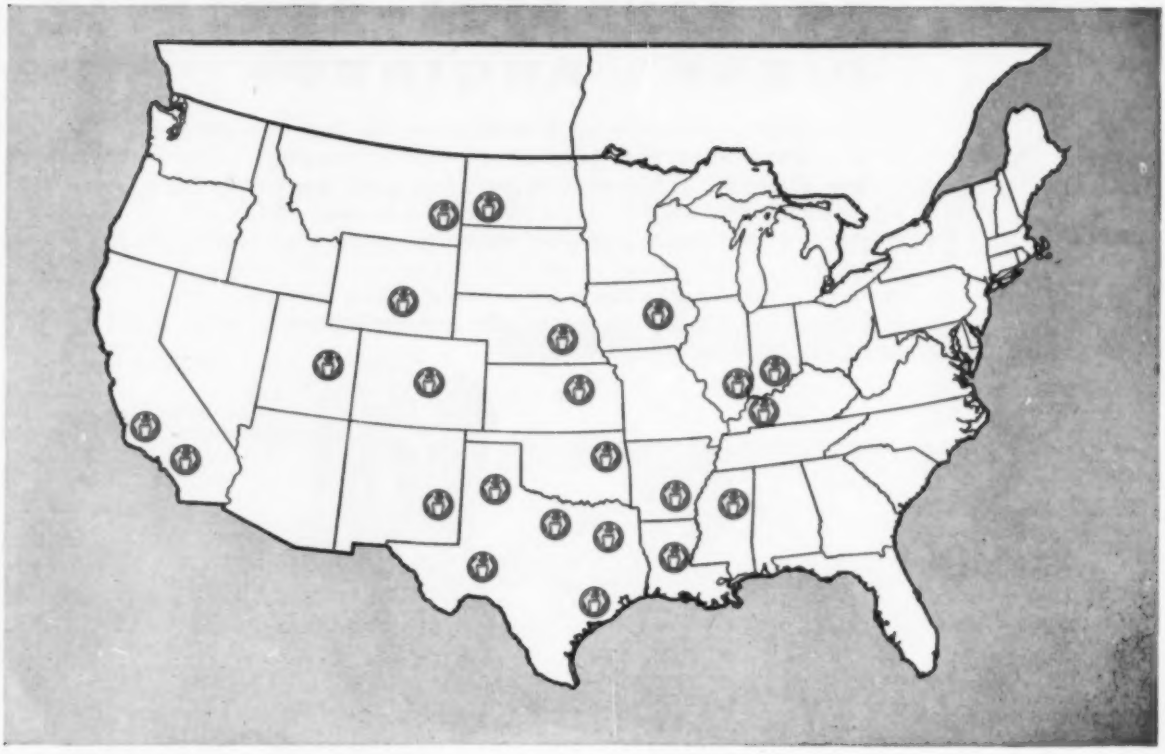

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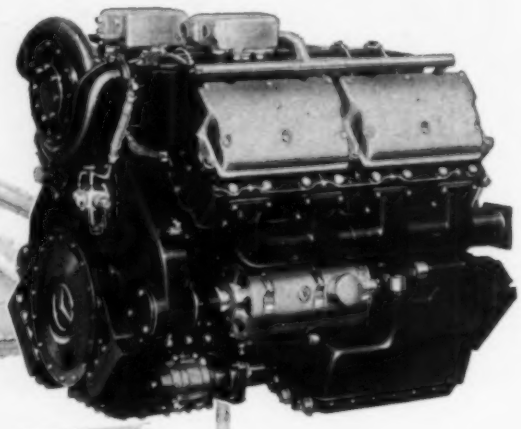
GIVE US AN OPPORTUNITY TO SAY YES

put FIRST financing in your own oil future

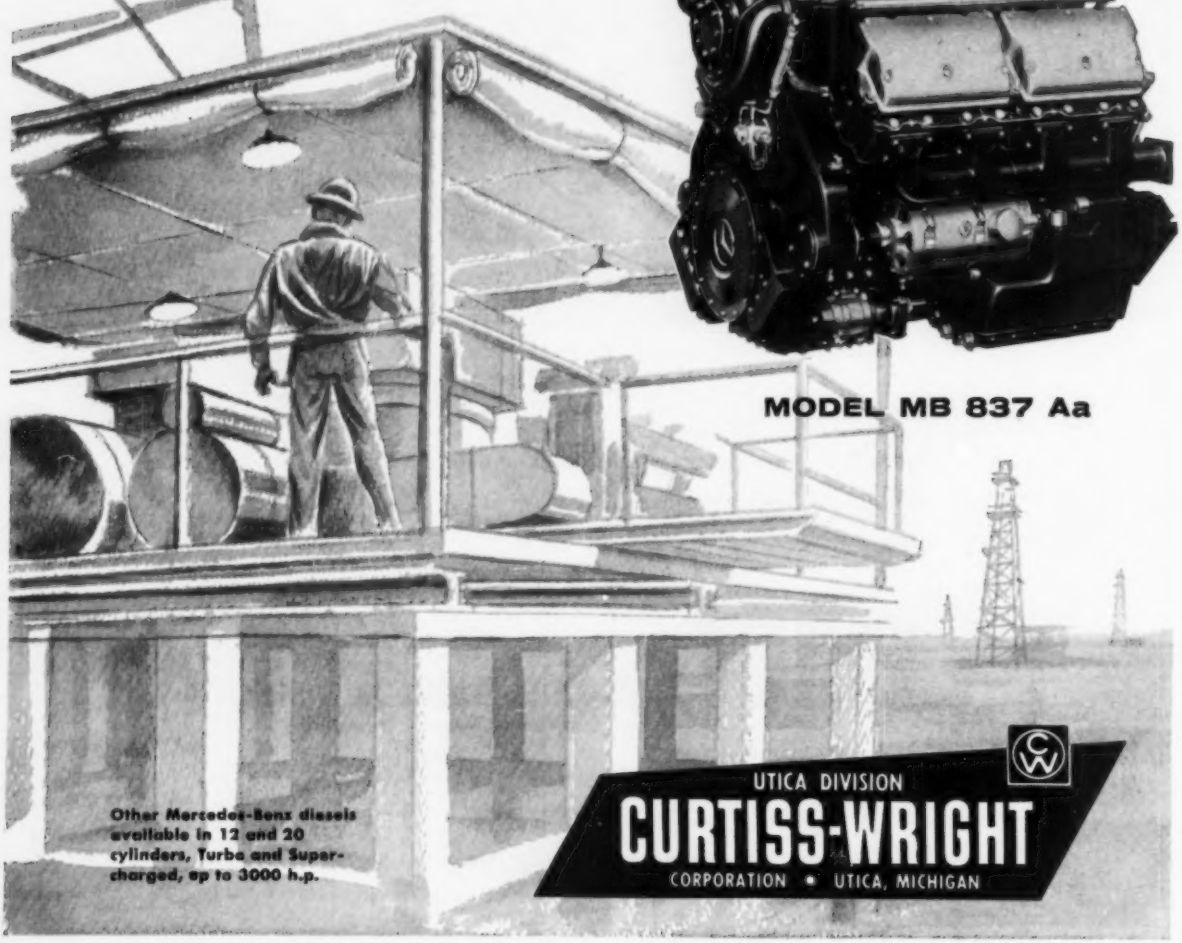
EFFORTLESS PERFORMANCE FROM START TO FINISH

MERCEDES-BENZ
DIESEL ENGINES

Mercedes-Benz diesel engines are powered to meet the toughest requirements of the petroleum industry—both inshore and offshore operations . . . They are designed and built to provide low-cost power for rugged, deep drilling, pumping, electrical generating and innumerable other specialized applications . . . High horsepower to weight ratio and compact size permit room for other rig equipment . . . Their unusually long engine life and exclusive Mercedes-Benz design allow continuous operation under extreme climatic conditions . . . Your Mercedes-Benz dealer can supply you with complete information on the full range of models from 36 to 3000 h.p.



MODEL MB 837 Aa



Other Mercedes-Benz diesels available in 12 and 20 cylinders, Turbo and Supercharged, up to 3000 h.p.

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Are you tired of people saying "OIL PROFITS ARE TOO HIGH"?

Here is some information that may be of interest to you and a revelation to some of your friends!

COMPARE OIL'S RATE OF RETURN ON NET ASSETS IN 1957 TO THOSE OF OTHER LEADING INDUSTRIES.

AUTOS & TRUCKS — 16.4%

CEMENT — 15.9%

CHEMICAL — 14.0%

OIL PRODUCTION AND REFINING — 13.6%

IRON & STEEL — 13.2%

ALL MANUFACTURING — 12.8%

Oil Profits Are Not Too High!

That's your easy answer to those who claim that oil profits *are* too high! Let them examine, as you have just done, oil's rate of return on net assets in comparison with those of the other leading industries listed above.

Remember these facts when the uninformed start talking about oil profits.

For more information about your industry clip and mail this coupon:

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Please send me additional information on oil industry profits.

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Management Personals

J. G. Jimenez was elected a vice president of Tidewater Oil Company and appointed general manager of the company's eastern division operations. Formerly eastern division marketing manager, he replaces **George F. Getty II,** who was recently elected president of Tidewater.

John W. Gendron, former administrative assistant to the president in San Francisco, was, at the same time, named assistant eastern division manager.

J. Earle Gray was assigned to full-time duties as manager of foreign operations of Tidewater Oil Company. Until recently Gray supervised foreign exploration and production operations in addition to his responsibilities as assistant general manager of the company's western division.

R. E. Foss, production vice president, **H. O. Harder,** exploration vice president, and **R. Paul Henry,** financial vice president, were elected to the new 15-member board of Sunray Mid-Continent Oil.

Russell B. Brown, general counsel of the Independent Petroleum Association of America, was the recipient of Texas Independent Producers and Royalty Owners Association's annual Recognition Award. "He was among the leaders of the domestic oil industry who fought successfully for an oil import duty in 1932, and has worked tirelessly since to keep alive the fighting spirit of oil and gas independents. Over the last quarter-century he has probably contributed more to the cause of uniting independent oil producers than any other person in the industry," said Jerome J. O'Brien, TIPRO president.

George M. Sullivan and **James S. Royds,** both of Houston, Texas, were elected administrative vice presidents of Continental Oil Company. Sullivan is general manager of marketing while Royds is general manager of exploration, and each will continue to be responsible for these same functions. **J. J. Dorgan,** Houston, assistant treasurer, has been elected treasurer. This position previously was held by **L. C. Peters,** also financial vice president, who will continue in the latter capacity.

George J. Sallee was elected to the board of directors of American Maracaibo Company, whose name is to be changed to Felmont Petroleum Corporation. He has been vice president of American Maracaibo since May 1955 and has been actively engaged in the oil operations of the company's subsidiary, Felmont Oil Corporation, since 1947 in his capacity as vice president.

G. T. Pearson, Fort Worth, has been appointed chairman of the Texas oil industry's public relations program for the next two years, it was announced in Dallas by Southwest OIC Chairman **J. L. Sewell.** Pearson is regional general manager of Continental Oil Company.

E. F. Bullard was elected chairman and **A. L. Solliday** was elected president of Pan American Petroleum Corporation, a subsidiary of Standard Oil Company of Indiana.

In other executive changes, directors also elected **F. R. Yost** executive vice president, and **C. F. Bedford** vice president of production.

Bullard has been president of the company since 1945. Solliday was elected vice president in charge of operations and a director in 1944, he became executive vice president in 1947.

The University of Arizona's 1958 Alumni Achievement Award was presented to **Dr. James A. Tong,** president of Socony Mobil Oil Company de Venezuela and a member of the University's class of 1918.

Daniel P. Barnard has retired from Standard Oil Company (Indiana) after 33 years.

Robert Di Giorgio, vice president of the Di Giorgio Fruit Corporation, has been elected a director of Union Oil Company of California. He is a director of the Bank of America, the Broadway-Hale Stores, and the Guggenheim Foundation.

Stewart H. Folk was named vice president of T.U.L.M. Corporation, consultants in foreign petroleum exploration and development for Tennessee Gas Transmission Company, Union Oil and Gas Corporation of Louisiana, Lion Oil Company and Murphy Corporation. Previously he had been vice president of Texas Gulf Sulphur Company subsidiaries conducting mineral exploration in Italy and other countries of the eastern hemisphere, and chief petroleum geologist of Texas Gulf Sulphur.

A. E. C. Drake, C.B.E., has joined the board of The British Petroleum Company. He fills a vacancy caused by the retirement of **Robert Gillespie,** C.B.E., who, however, will remain on the boards of BP Tanker Company, Ltd., and BP Clyde Tanker Company, Ltd.

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Next time you need a good, heavy-duty crawler crane for heavy lifting around refineries, yards, booster stations, drill sites, check what this Koehring 305 will do for you. It safely lifts up to 15 tons. That's based on conservative 75% rating. Butt-connected boom can be extended from 35 to 80 feet. Inserts are safe, solid — easily changed — only 2 bolts per corner. When extra reach is needed, the Koehring 305 handles 15 to 20-foot jib on 80-foot boom — raises maximum 100-foot boom and jib with low A-frame!

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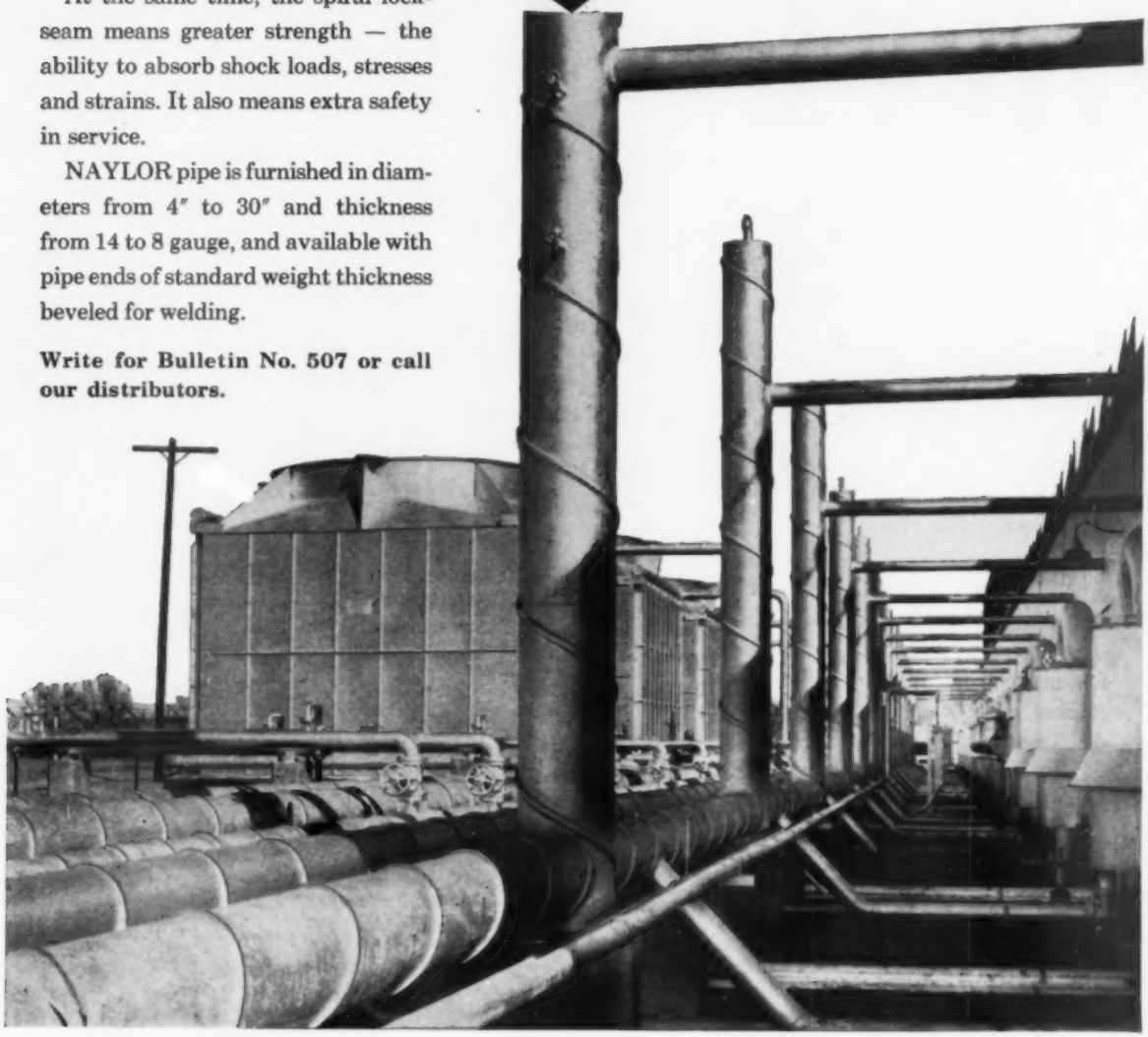

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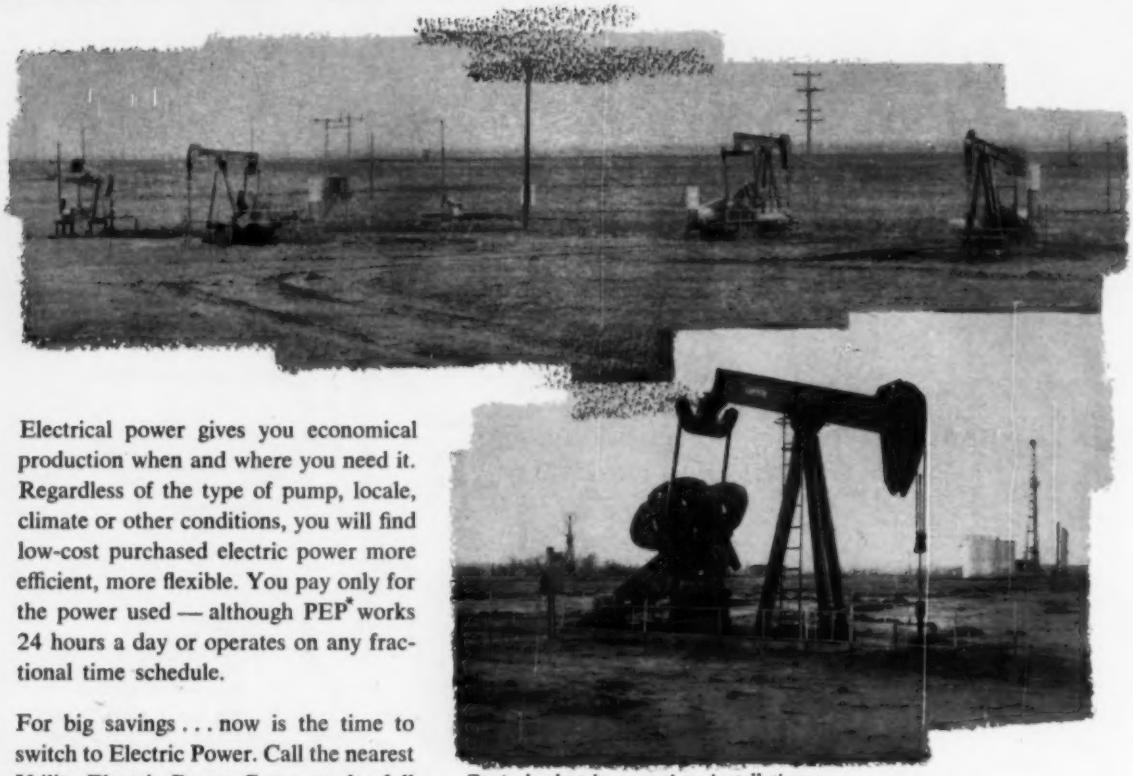

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Worthington KCA pump offers you highest displacement, most pressure, low cost

The new KCA waterflood and salt water disposal pump has just been introduced by Worthington. This new pump has the highest displacement of all comparable competitive models—fully 23% more barrels per day. It also delivers the most pressure. And it's priced at only $38 per input horsepower.

The KCA has 6 outstanding economy and efficiency features:

1. **Interchangeable plungers** over widest available diameter range (1¼ to 2½ inches). Permits changes within any stuffing box range without changing fluid end. Available as ceramic or hardened stainless steel.
2. **Straight-flow design** for maximum volumetric efficiency.
3. **Maximum stuffing box accessibility.** There are no partitions in power end cradle.
4. **Suction air chamber,** packing and stuffing box cover are standard equipment.
5. **Large pipe connections,** 3 inch suction, 2 inch discharge on either side.
6. **Wing-guided valves,** liberally sized suction and discharge valves both removable through single top cover.

For details, see your Worthington district office. Or write: Worthington Corporation, Section 32-1, Harrison, N. J.

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HIGHEST DISPLACEMENT

Worthington KCA	2300
Brand A	1860
Brand B	1590
Brand C	1300
Brand D	1055

MAXIMUM DISPLACEMENT IN BARRELS PER DAY*
*At normal ratings. Some manufacturers, including Worthington, will permit higher speeds, capacity and horsepower after approving suction conditions. Best performance, however, is obtained by staying within normal ratings.

MOST PRESSURE

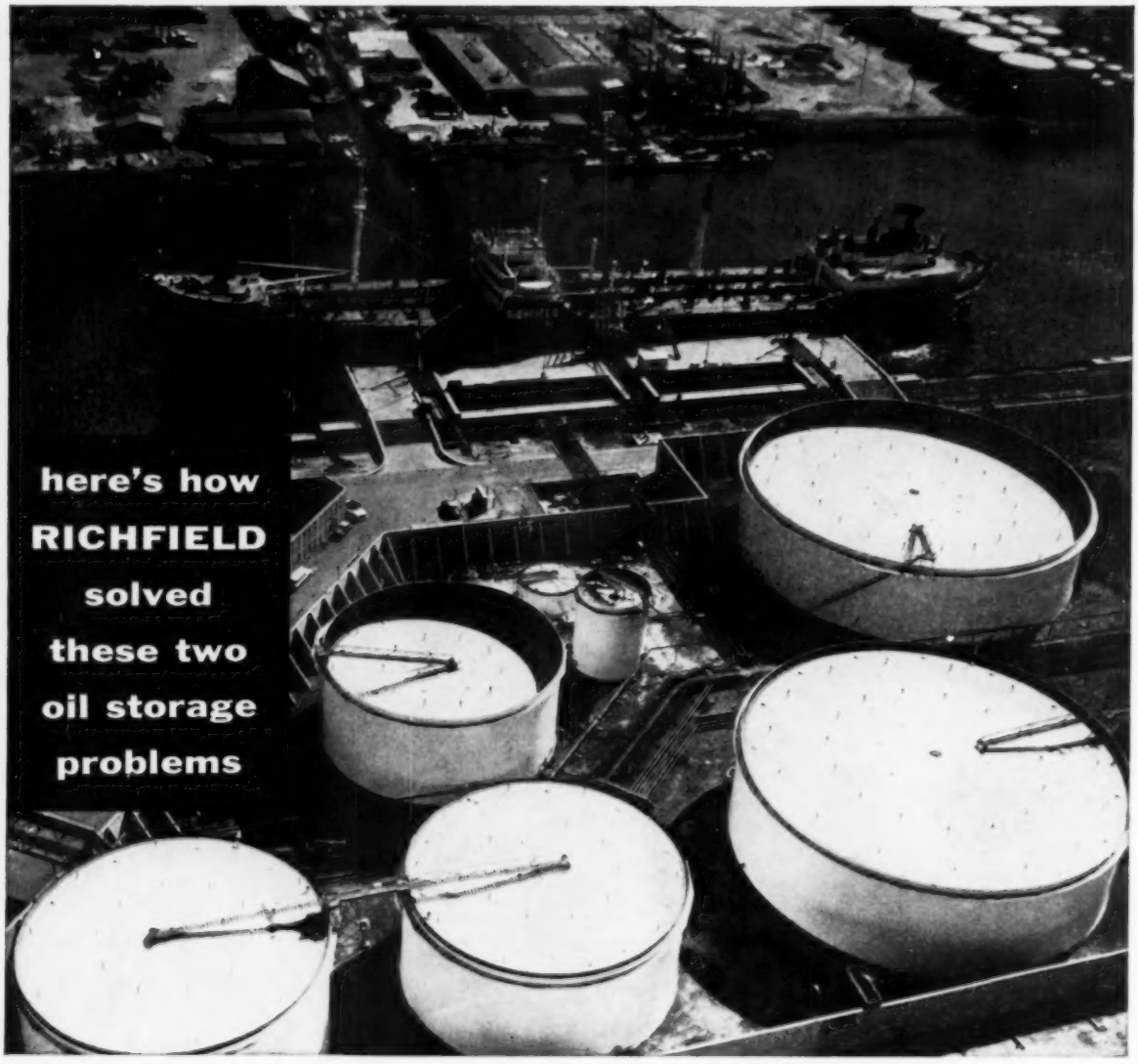
Worthington KCA	3100
Brand A	3000
Brand B	3050
Brand C	1490
Brand D	1550

MAXIMUM PRESSURE—PSI

LOW COST

Worthington KCA	$38
Brand A	35
Brand B	46
Brand C	58
Brand D	47

COST PER INPUT HORSEPOWER—NORMAL RATINGS



1. Fire Hazard 2. Vapor Loss

Here is an investment by Richfield Oil Company that pays off in safety and conservation. It is a seven-tank addition to Richfield's Marine Terminals that adds half a million barrels capacity. The tanks, built by General American, are equipped with Wiggins Floating Roofs with Wiggins Safety Seal that stops vapor loss and protects from rim fires.

Wiggins Double-Deck Floating Roofs with the Wiggins Safety Seal, reduce vapor space under the circumferential fabric to an absolute minimum. This practically eliminates losses due to thermal breathing and serves to prevent rim fires. The fabric is of a new, long-lived type and a special weather-hood protects it from the sun. The seal mechanism is always out of the liquid and the corrosive vapor space. Only the Wiggins Safety Seal gives you all these advantages.

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▸ Vice President **Thomas L. Wark** has been appointed special assistant to the president of Tidewater Oil. Wark was formerly western division general manager, with headquarters in San Francisco.

Vice President **Charles R. Brown** has been named western division general manager, succeeding Wark. Brown's prior post was central division general manager in Tulsa.

Lloyd Armstrong, previously southern division assistant general manager, with Houston headquarters, has been appointed central division general manager, succeeding Brown.

▸ **Henry E. Winter** was appointed executive representative in Venezuela of International Petroleum Company, Ltd. He will succeed **Edmund C. Breene, Jr.,** who is retiring after 24 years service with International and other affiliates of Standard Oil Company (New Jersey). Winter joined Jersey Standard's producing coordination department in New York as regional coordinator for Latin America in 1954. He was transferred to Coral Gables in November, of 1956 and since that time has been Venezuelan coordinator.

B. B. Miller R. M. Churchwell G. R. Schoonmaker

▸ **B. B. Miller,** former superintendent of Ohio Oil Company's Robinson, Illinois, refinery, is the new assistant to the president. He succeeds **R. M. Churchwell,** who becomes manager of foreign operations, a newly created position. **G. R. Schoonmaker,** former assistant manager of foreign production, also steps into a new position, manager of foreign exploration.

W. J. (Woody) Wilson has retired from Ohio Oil Company. He was assistant manager of administrative services.

DEATHS

▸ **John P. McKinley,** 47, district landman for Hunt Oil Company, died May 30 in a Midland, Texas, hospital shortly after being stricken with a heart seizure.

▸ **Jack E. Clemens,** Houston division manager for the Martin-Decker Corporation of Long Beach, California, died suddenly May 19.

▸ **James M. Tough,** district manager of the Atlanta, Georgia, territory for the forge and fittings division, W-S Fittings Works, H. K. Porter Company, Inc., died May 10 in Atlanta.

▸ **J. L. Shoemaker,** 57, financial vice president of Service Pipe Line Company, died May 26 at his home in Tulsa.

▸ **Clifford D. "Shorty" Cobbett,** a veteran of 28 years with Hill Hubbell & Company, died of a heart attack May 9 at the Pittsburgh Airport. He was a well-known figure in the pipe-wrapping industry.

▸ **John T. Dillon,** 74, chairman of the board of Struthers Wells Corporation, died May 12.

▸ **Harry B. Schramm,** 43, vice president of research and development for Otis Engineering Corporation in Dallas, Texas, died unexpectedly at his home May 1.

▸ **Andrew M. Rowley,** 69, oil columnist and former oil editor for *The Tulsa Tribune,* died May 14 in a Tulsa hospital where he had been under treatment for heart and kidney ailments.

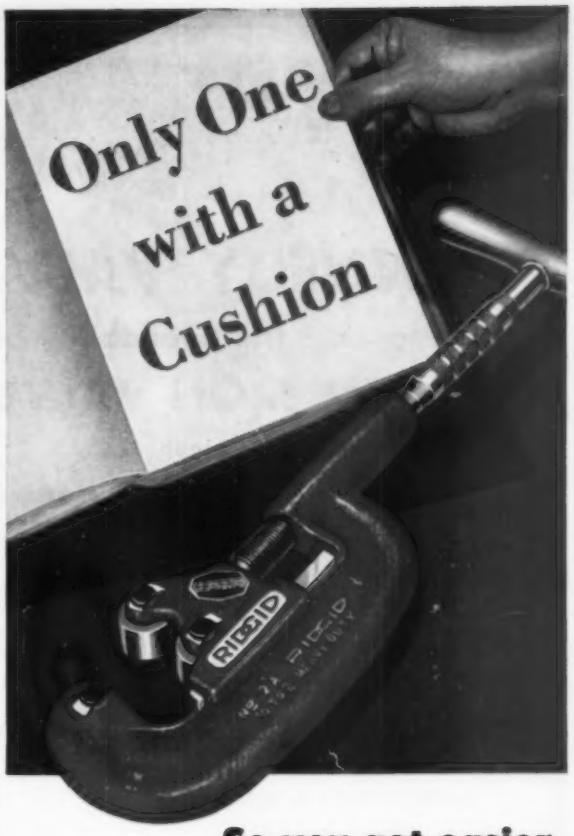
▸ **R. C. Crabb,** 76, Midland, Texas, independent oil operator, died May 17.

▸ **Frank G. Straka,** 53, chief coordinating engineer of Universal Oil Products Company, died May 17.

▸ **Dr. Vsevolod N. Krivobok,** 65, supervisor of the stainless steel and heat-resistant alloy section of the development and research division of The International Nickel Company, Inc., died May 17.

▸ **William Hunt Eisenman,** 73, secretary and founder-member of the American Society for Metals, died May 30 in a LaJolla, California, hospital.

▸ **John S. Patchin,** retired assistant plant manager of the Philadelphia refinery of The Atlantic Refining Company, died at the age of 65, after 37 years of service.



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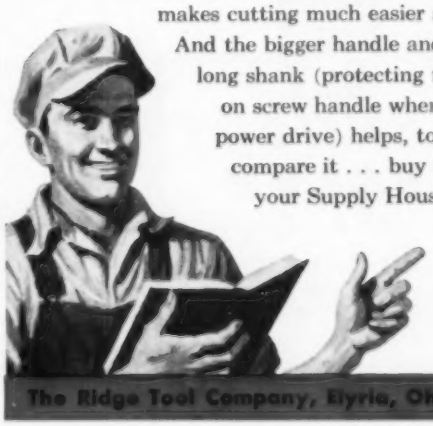

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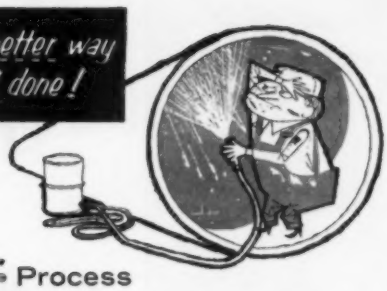

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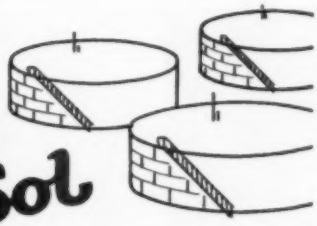

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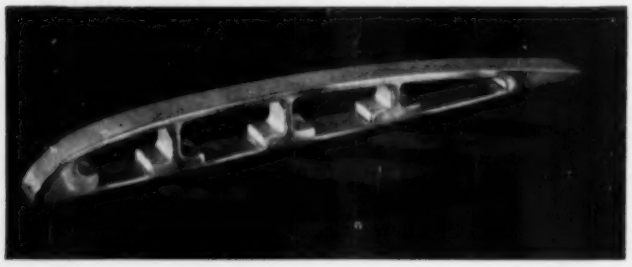

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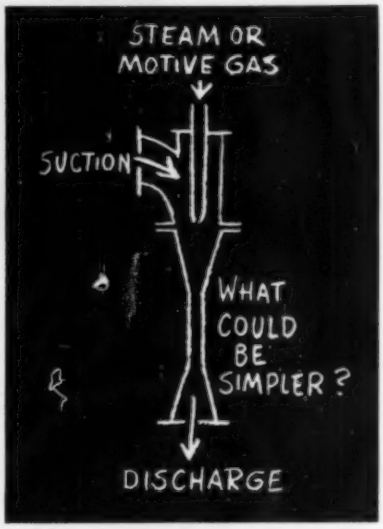

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A Guide to Books

Design of Concrete Structures, *by Leonard Church Urquhart, Charles O'Rourke and George Winter. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. Pages, 456. Price, $8.*

This is the sixth edition of a well-known concrete design text that reflects all changes introduced in the revision of the American Concrete Institute's Building Code issued in 1956. The authors cover the entire field of customary reinforced concrete design — with the exception of some highly specialized structures. Emphasis is placed on a thorough discussion of basic structural performance, fundamental mechanics, and physical explanation.

The Future Supply of Oil and Gas, *by Bruce C. Netschert. Published by Johns Hopkins Press, Baltimore 18, Maryland. Pages, 144. Price, $3.*

This new book, published for the Resources for the Future, Inc., brings together most existing published estimates of oil and gas reserves and resources by leading scholars in the fields. These are systematically reviewed. The differences in techniques, assumptions, and definitions are analyzed; and all estimates are adjusted in accord with a set of uniform definitions. The text is primarily an inquiry into the availability of crude oil, natural gas liquids in the U. S. until 1975. Every effort is made to analyze economic, technological and geological variables.

Petroleum Sourcebook — 1958, *published by National Petroleum Bibliography, Box 3586, Amarillo, Texas. Pages, 188. Price, $6.*

Classifying petroleum information by geographic regions, the new publication lists some 4000 information sources covering 82 countries and 82 states, provinces, and geographic regions. More than 500 special publications of value to oilmen are classified, as well as the regional material from nearly 100 trade magazines and journals.

Compiled from 1000 pages of literature references issued in 1957 by National Petroleum Bibliography, the book is designed to place in one package the location of petroleum information most often sought by well drillers, geologists, petroleum engineers, executives, and researchers.

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MERCANTILE NATIONAL BANK
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Fast turn-around is standard procedure at Levingston for tugs, barges and other types of marine vessels. At Levingston you're assured of superior construction and unequalled experience on your job regardless of how small or large it is. Always remember, it's just good business to call Levingston.

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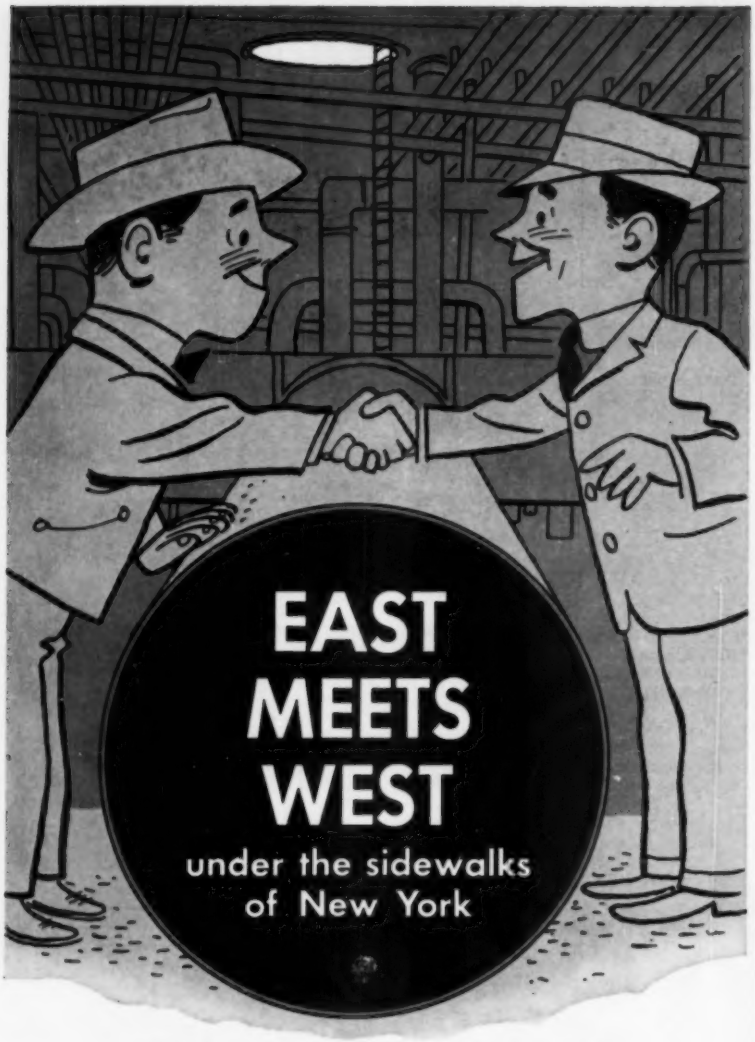

Natural gas consumers on the eastern seaboard never give a thought to the old maxim about that gap between East and West. Under their cities run dependable connecting pipelines to gas fields west of the distant Mississippi. Transco is privileged to take your gas where the most people are: through Transco the twain will always meet to their mutual advantage.

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

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APPLICATION ENGINEER — This work is a part of a product-service group within an engineering department. You should have a keen interest in applying apparatus to the needs of the oilfield lease operator. You will be a link between the salesmen and the engineering group. Technical writing is a part of the work. For this job, we believe you should have 2 years or more experience with oil-country equipment as a gas engineer or production engineer. Some of this might well have been in sales work.

If this opening interests you, please send us a resume of your experience. We will reply promptly and your application will be held in confidence. Salary for this position is open and will depend upon your experience and ability.

Address your reply to

The Parkersburg Rig & Reel Company
Box 12007, Fort Worth, Texas

FRANCHISE AVAILABLE

Oilfield service companies are needed to handle and operate the field-proven Macro C.F.E. (Casing Failure Elimination) Tool throughout the U. S. This new tool is used to pressure-test casing in the well bore prior to cementing and has been proven in testing over 1 million feet of casing in Canada. Please write or call:

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Phone: AMherst 9-8174 or AVenue 9-6592

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Age 32. College graduate. Brief production experience. Seven years experience selling to oil industry on executive level. Prefer sales or public relations. *Will travel.*
Box 198, c/o The Petroleum Engineer.

WANTED — Assistant manager, drilling superintendent and petroleum engineer, all in one man, to supervise 2½ year foreign one-rig drilling operation. Top salary. Bonus. Send complete resume and references. All replies held strictly confidential.
Box 199
Petroleum Engineer
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CONTINUOUS RESEARCH AT CATERPILLAR LABORATORIES IS EXTENDING ENGINE LIFE THOUSANDS OF HOURS

EXAMPLE: Lube oil filter elements that give greater protection for longer periods at less cost

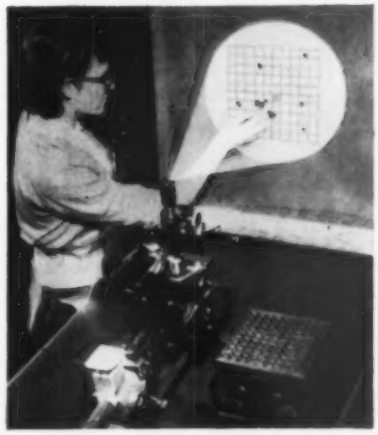
The development of new, additive lubricating oils has reduced oil change requirements. Cat filters have kept pace with these improvements. Cat filters have greater *dirt-holding capacity* to filter efficiently over the entire *extended* periods. This means a big saving to every owner of Caterpillar equipment.

FILTER TEST STAND adds controlled amounts of dirt to lube oil to check how much dirt an element can hold before plugging. Unless this is determined, replacement recommendations cannot be made. Of all the filter makes tested, only Cat filters completely met Cat Engine requirements.

Most oil filters of other makes fall far short of meeting Cat filter replacement recommendations—usually because they have *insufficient* dirt-holding capacity (not enough filtering paper) or they filter harmless, too-fine particles which quickly load up the element, opening the safety bypass. As a result, unfiltered oil is allowed to circulate, causing rapid, premature wear.

You can't get maximum engine life unless you filter *full time*. The best way to insure long engine life, peak performance and operating economy is to standardize on Caterpillar oil filters. They are the only filters you can count on to give full-time protection over the entire filter change period that is recommended for your Caterpillar Engine. See your nearby Caterpillar Dealer today.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.



PROJECTION MICROSCOPE magnifies 500 times particles that pass through filter paper so they can be measured. Since precision bearings ride on an oil film, particles smaller than the oil film can cause no measurable wear even after thousands of operating hours. Too-fine filtering shortens filter life needlessly.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

This contractor saved $1,822.24 in one year in oil changes

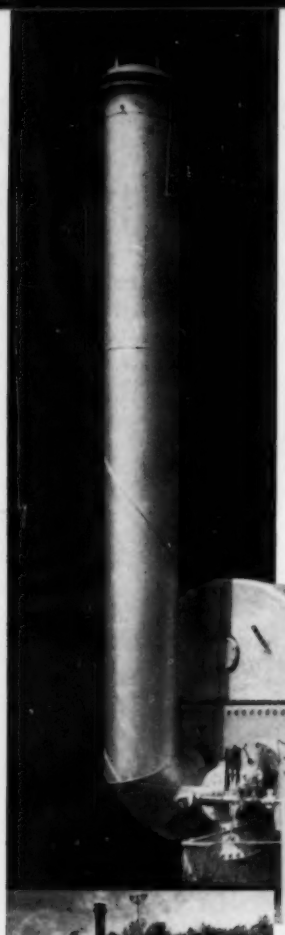
SERVICE TIP

Complete information on oil changes is provided in Form 32421-1, *Crankcase Lubricating Oil Change Period Recommendations*, available from your Caterpillar Dealer. These recommendations are tested and proven. When used with Cat filter elements, you'll get maximum protection for your equipment at the lowest cost.

Many Caterpillar owners tend to play it safe by changing lube oil and filter elements far more frequently than recommended; thus they are willing to gamble on lower-priced, small-capacity filter elements. This is false economy. Here is an actual experience of a contractor, owner of eight Caterpillar D8 Tractors, who followed recommended procedure with Cat filters:

Past Procedure — Oil changed every 80 hours		**Cat Recommended Procedure — Oil changed every 150 hours**	
Lube oil @ $1.25 per gal. 9 gal. per change	$11.25	Lube oil @ $1.25 per gal. 9 gal. per change	$11.25
[redacted] filters @ $1.00 ea. 3 per oil change	3.00	Caterpillar filters @ $1.14 ea. 3 per oil change	3.42
Labor cost	2.50	Labor cost	2.50
Total cost per change	$16.75	Total cost per change	$17.17
Ave. operating hours per year	2,400	Ave. operating hours per year	2,400
Ave. oil changes per year	30	Ave. oil changes per year	16
Total cost per machine per year	$502.50	Total cost per machine per year	$274.72
Total cost for eight D8s	$4,020.00	Total cost for eight D8s	$2,197.76

D8s — 2U, 14A and 15A Series Tractors · Lubricating oil used: Series III · Fuel sulphur content: .4% to 1.0%



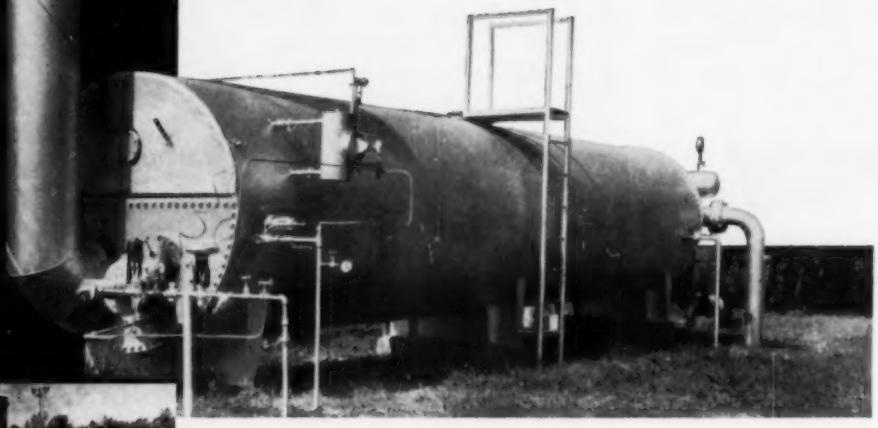
Problem

Lower pipeline pressure to prevent production curtailment

SOLUTION — one NATIONAL®

6′ x 32½′ Indirect Heater

PATENTED



In an East Texas field during the winter months, it was necessary to man a pump station 24 hours a day. The station was pumping 2,760 BOPD with part of the crude bypassing through a relief valve to the pump suction. The high line pressure of 920 psi and automatic bypassing of the pump was caused by pumping cold viscous crude. Under these conditions, the station was handling only about 50% of the field allowable which was a 50% curtailment in production.

After installing the low pressure drop National Indirect Heater, designed by National's experienced engineers, the pump rate was increased to the field allowable of 4,650 BOPD, with no oil bypassing and with a maximum line pressure of only 800 psi — a drop of 120 psi **while handling twice the volume of crude.**

Since this new automatic heater required no attendant, the field pump station was made an unattended station, and the station allowed the additional through-put of 1,890 BOPD.

HEATER OPERATING CONDITIONS

Oil inlet temperature	69° F.
Oil outlet temperature	118° F.
Inlet pressure, heater	690 psi
Oil outlet pressure, heater	680 psi
Water bath temperature	190° F.

NATIONAL INDIRECT HEATERS FOR GAS, OIL AND WATER ARE AVAILABLE IN WORKING PRESSURES TO 15,000 psi TEST.

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Good equipment

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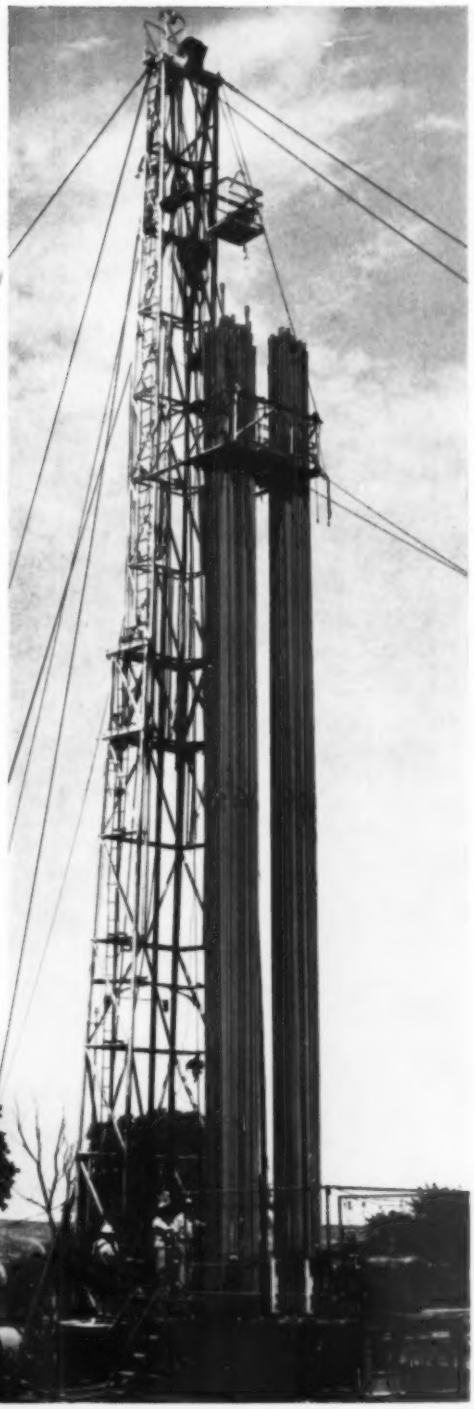


At the times when there are many yards full of well servicing and workover units, the contractor with the type of equipment oil company superintendents consider as preferred, has an advantage in getting the available contracts.

Franks units, plus a good crew, have such a reputation. They make for fastest possible moving, rig-up, and actual pulling. Franks telescoping derrick unit moves strung-up, levels easily, and guys to the unit. Franks air lift transfer provides speed in pulling and stacking protects rods and tubing.

Franks Rocket models from 6,500 to 12,000 ft.

Get details from your Franks representative. He is qualified to help you select the Franks model most economically suited to your work.

WELL SERVICING AND DRILLING UNITS

FRANKS

DIVISION OF

PAMPA, TEXAS

CABOT

WATCH FOR FRANKS SPECIAL

Carlos Canalizo, Otis Development Engineer and Gas Lift Authority, Says

"In times like these...can you afford to lose a dual well? You might, if you can't rotate the pipe."

DON'T RUN A RISK...RUN CONCENTRIC COLLAR-SIZED, FULL-OPENING OTIS TYPE C GAS LIFT VALVES FOR DUAL-COMPLETIONS

Q. Carlos, that's an alarming thing . . . losing a well these days. How can a single precaution like concentric valves save a well?

A. It's as simple as these diagrams. In any parallel-string completion, if two strings with *eccentric* mandrels are run, there is absolutely no way to rotate either string, because the valves will not clear the other tubing string. *However*, if the gas lift valves on at least one of the strings is an Otis Type C, that string *can* be rotated because the Otis valves are collar-sized . . . as shown in the sketch on the right.

In any dual well, you need the flexibility of being able to rotate the tubing. It is *desirable* in both strings, *but absolutely necessary* on the short string.

Q. You said the Otis Type C is full-opening and collar-diameter. Where's the valve mechanism?

A. The Otis valve is built *around* the mandrel rather than inside or alongside it. Thus it has an unrestricted bore, yet it's absolutely cylindrical. The 3 1/16" O.D. x 2" I.D. Otis valve is the only concentric, full-opening, collar-sized valve on the market. By the way, this valve also has an excellent application in slim-hole single-completions.

Q. Is the same design available in a removable valve?

A. Yes, in the Otis Type F that I'm holding in my left hand. The Type F is run and pulled with standard kick-over tools and wire line methods and can be seated in a conventional side-pocket mandrel or in an Otis retrievable concentric mandrel. The Otis concentric mandrel can also be rotated, and with the valves pulled, the bore is essentially full-opening.

Actually, our valves have more important, exclusive operating features than any valve on the market. If you will contact one of the many Otis branches throughout the oil country, they will be glad to advise you on selecting the best string of valves for your wells. You will find them friendly, courteous, and well qualified, and anxious to help you at all times.

OTIS Engineering CORPORATION

Branches Throughout the Oil Country

Of Things To Come . . . In Oil

IF OKLAHOMA CAN PRODUCE 600,000 BBL DAILY, it will soon be known. State Corporation Commission has called for testing of all of Oklahoma's allocated oil wells during the month of July. State will base its future output allowables on its findings. Wells not tested before August 1 deadline will lose allowable quota. It has been maintained — and challenged — that Oklahoma can produce 600,000 bbl of oil per day without waste.

PRORATIONING, WELL TESTING BY STATE CONSERVATION BODIES will bring hair-pulling and finger-pointing in hot summer months to come. Texas will spend summer seeking equitable method of prorating gas. Oklahoma commission will take further looks at recently rejected yardsticks at prorationing (by depth classification). New Mexico is analyzing results of its newly imposed deliverability tests in Southeast part of the state. Colorado unitization rules are being scrutinized as sidelight to Adena field unitization violation case. In North Dakota, changes in rules governing testing of wells in different deep zones are being asked by Amerada. Louisiana is studying method of including reserves into allowable awards.

"THIRD STRIKE" FOR SOUTHWEST DRILLERS' UNIONIZATION may pose strength problem for International Union of Operating Engineers (CIO-AFL) as to future oil country growth. Most recent defeat was suffered by union at hands of Phillips Petroleum Company's drilling tool division employees. Over 200 drilling employees voted 3 to 1 against representation. In recent months, union has been rejected by well servicing employees and drilling employees on West Texas contract rigs.

INCREASED FOUR CORNERS CRUDE BUYING, for West Coast markets, will keep Southeast Utah and Northwestern New Mexico exploration and development "hot" for months to come. Take is now 47,000 bbl per day from 255 Utah wells and 23,000 bbl daily from 600-plus prorated New Mexico wells. Added incentive is newly-reduced Four Corners pipeline tariff from 55 to 50 cents a barrel.

"ONLY 45,000 WELLS THIS YEAR" — maybe — says J. U. Teague, president of American Association of Oilwell Drilling Contractors. Speaking before Dallas-Fort Worth AAODC meeting recently, Teague cited that contractors are operating at 60 percent of capacity — and no worse off than many other businesses curtailed by recession. Contractors, he says, will be last to recover from dilemma — to them a depression, not just a recession.

HALLIBURTON'S WATERFRAC

with built-in breaker

MAXIMUM SAFETY and ECONOMY

Originally developed as a fracturing fluid for water wells, Halliburton's WATERFRAC is finding increasing application in oil and gas wells with formations insensitive to water.

WATERFRAC uses gelled fresh water, salt water or oil field brines. It combines safety, economy and convenience with its effective stimulation. Its internal breaker and dilution by water permit operation of the treated well with minimum delay.

The success of WATERFRAC in the production stimulation of oil and gas wells may be illustrated by its record: In some cases, the average sustained production after treatment has been reported to be four times initial flow!

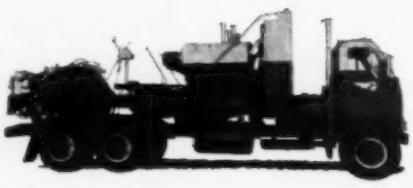
Although WATERFRAC has low fluid loss properties and carries sand well, it offers moderately low resistance to pumping. Temperature stability allows successful fracturing at bottom hole temperatures up to 200° F. Special additives may be incorporated in the gel to make it more adaptable for fracturing some formations normally adversely affected by water. In certain formations, such as limestones and dolomites, varying amounts of acid added to the gel are beneficial.

Put the advantages of WATERFRAC in your well! For more information about WATERFRAC (and many other Halliburton stimulation techniques), ask for a free copy of the newly revised bulletin, "Elements of Hydraulic Fracturing". Call your nearby Halliburton Fracturing Engineer . . . now!

FIRST AND FOREMOST IN FORMATION FRACTURING

HALLIBURTON FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY, DUNCAN, OKLAHOMA



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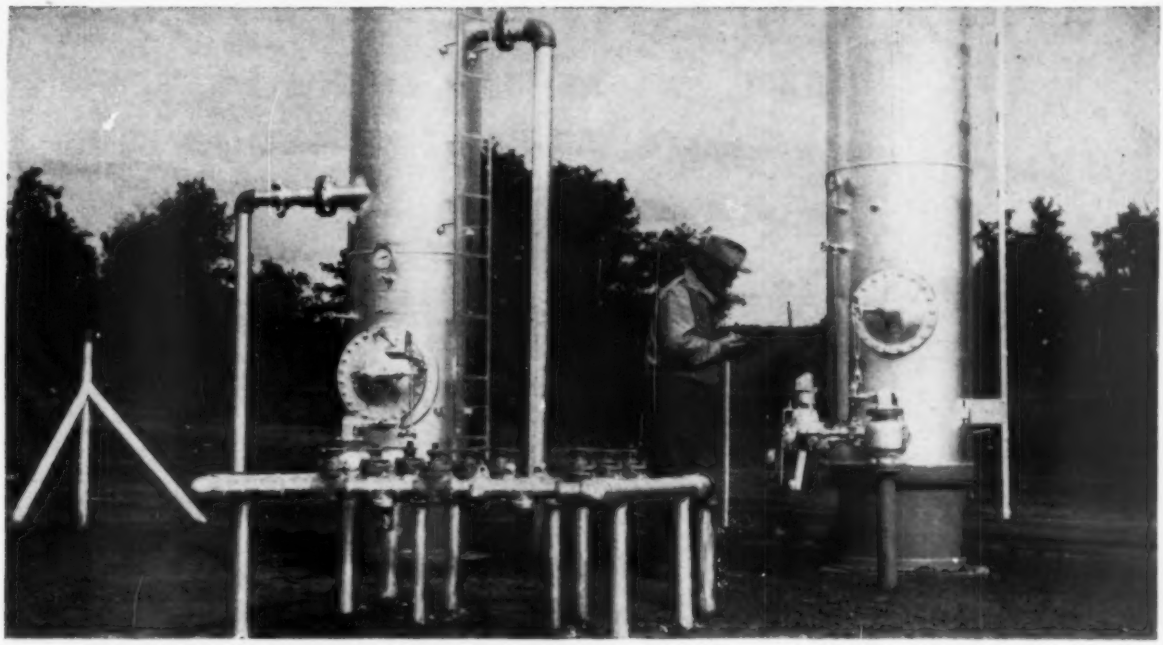
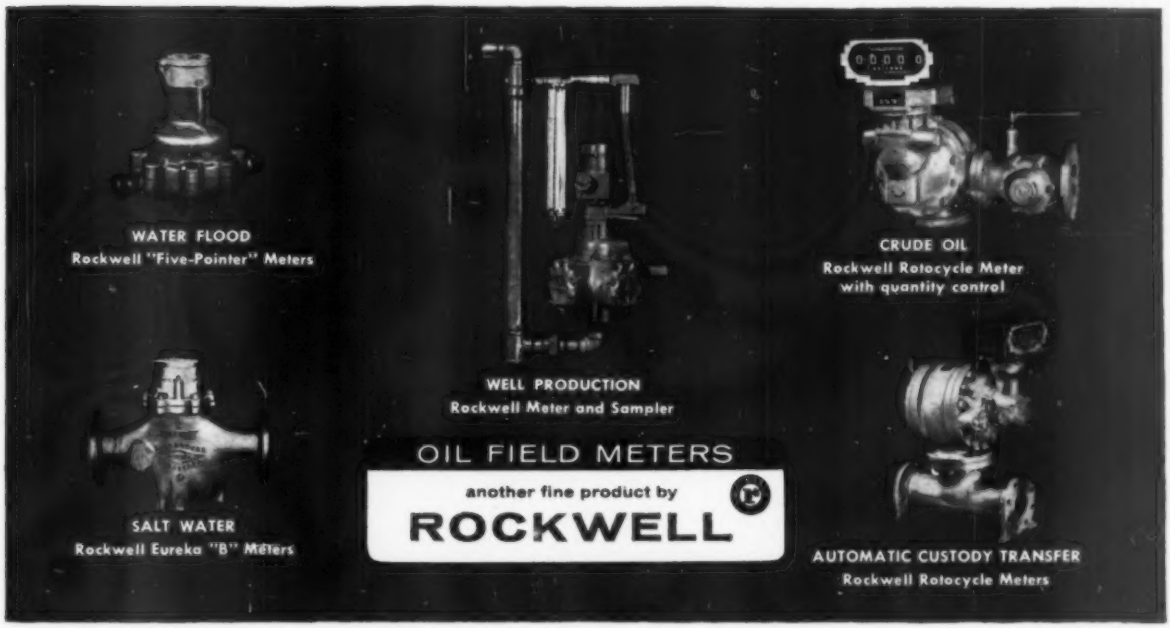
What do you want to measure?

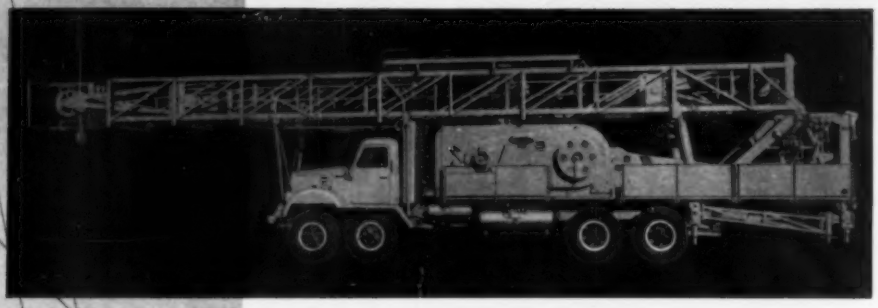


FOR OIL FIELD METERING ROCKWELL HAS WHAT IT TAKES

Specialized Rockwell meters and accessories answer your needs for every oil field measurement requirement. Whatever the liquid, whatever the service, you can select with confidence from the complete Rockwell line. Accessories including impulse contacters, temperature compensators, etc. are available. For catalogs or help with any measurement problem, write Rockwell Manufacturing Company, Pittsburgh 8, Pa.



DIAMOND ROLLER CHAIN DRIVES ARE USED THROUGHOUT ON THE NEW CARDWELL K-251 WELL SERVICING UNIT



■ On *all* rigs, performance depends heavily on power transmission—and leading manufacturers like Cardwell rely on Diamond Oil Country Roller Chains to deliver the power.

Experience has shown that the uniform superior construction of Diamond Chain means longer service life, less maintenance, minimum downtime and more profitable drilling.

It is significant that in this field, where so much depends upon power transmission, more rigs are standard equipped with Diamond Chains than any other—and that more oil field stores sell more Diamond replacement chains than any other.

Buy Diamond now, see how Diamond Chain can cut drilling costs for you.

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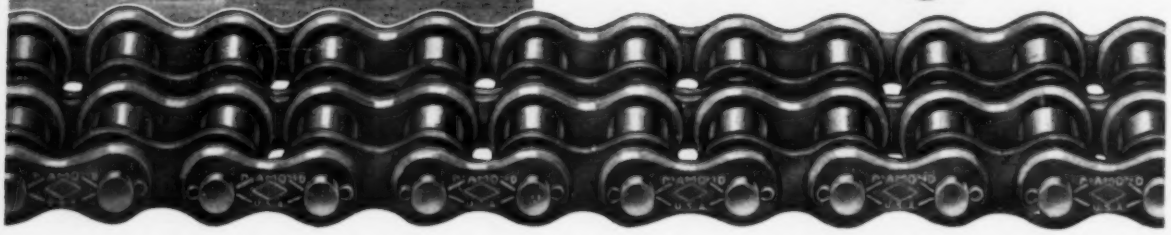

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Continental-Emsco "D" Series Pumps have proven themselves on drilling locations the world over.. proven they are heavy enough to handle the volumes and pressures demanded by modern drilling.. yet light enough to save you money in transportation costs and rig-up time.

This *proven* combination of weight and performance comes from weight reducing Fabriform construction and a rugged herringbone gear train that provides smooth, steady power. With Fabriform, steel plates and shapes are used in place of heavy, bulky single castings.. giving you low weight with improved performance. Simplified maintenance is another time-saving feature of the "D" Series Pumps. There are no power end adjustments to make .. no greasing to do .. lubrication is completely automatic.

More *proven* advantages are yours with Continental-Emsco Slush Pumps.. get all the facts about big performance.. low weight "D" Series Pumps.

SIX SIZES – D-175, D-300, DA-500, D-700, DA-850, D-1000

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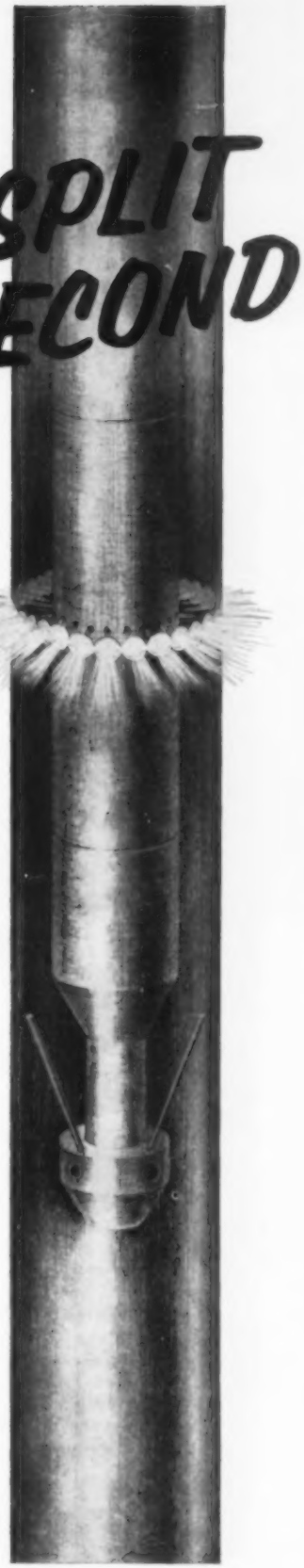
Cuts tubing in a SPLIT SECOND



CHEMICAL CUTTER RECOVERS 13,788′ OF TUBING

This oil well was a dual completion with two strings of tubing inside 7″ OD casing. Operator was unable to pull 2″ tubing. McCullough Magna-Tector (Free Point Finder) was run—found packer stuck at 13,899′. An unsuccessful attempt was made to jar the packer loose with a String Shot.

McCullough Chemical Tubing Cutter was then run to 13,788′, cut was made and tubing removed from the hole. All wire line operations were completed in nine hours rig time in spite of severe complications—extreme depth, tubing restricted by choke valves, and 800 lbs. pressure on tubing during operations.

McCullough

CHEMICAL TUBING CUTTER

Here's a "split-second" tubing cutter that will save more than 80% of the rig time usually required to cut tubing by mechanical methods. It is an electric wire line tool which applies the enormous power of the halogen fluorides to cut through tubing quick as a wink.

McCullough's Chemical Cutter makes a clean, flare-free cut—no burrs nor distortion on either the OD or ID of the tubing. Cutting operation is junk free, since no part of the cutter is expendable. It will not damage casing even though the tubing be as close as 1/64″.

Ask your McCullough Service Engineer about this revolutionary new service. Available for 2″ or 2-1/2″ tubing at all McCullough Service Locations.

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Service ANYWHERE ANYTIME

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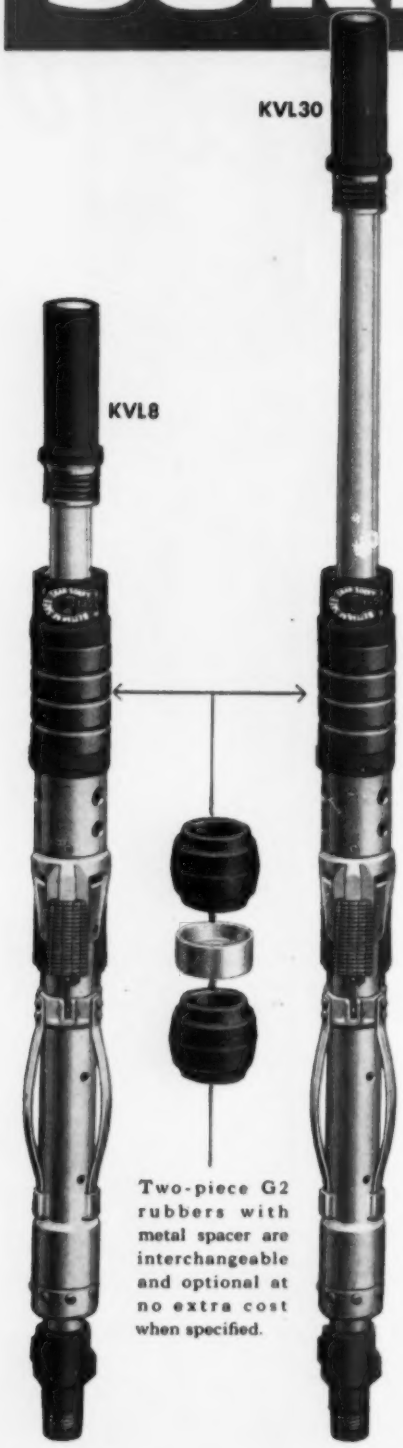
GUIBERSON'S KVL PACKERS



Two-piece G2 rubbers with metal spacer are interchangeable and optional at no extra cost when specified.

With Automatic Latch

Operators who want extra assurance that a packer won't come unlatched going in, depend on Guiberson KVL packers. Rugged and durable, KVL packers have earned a reputation for dependable performance in deep and medium depth wells. These retrievable packers are easy to set and release, with ample bypass and positive seal. When running into a liner the KVL stays latched and drag springs provide an excellent guide — features operators like. For conserving gas energy and increasing production in flowing wells; for completing wells by circulation; for acidizing, repressuring and dozens of other uses, the KVL is unsurpassed.

- Made as the KVL30 with 30″ valve stroke or KVL8 with 8″ valve stroke for standard below-packer circulation. (Both packers also made with perforated mandrel for circulation above packer.) Available in casing sizes 5″ through 9⅝″.
- Valve has two independent sealing elements, a tapered metal valve and seat and a set of oil-resistant seal rings, affording double-sealed protection.
- Rubbers made of special oil and gas resistant compound. Will not vulcanize to casing — recover original shape when released.

THE GUIBERSON CORPORATION

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Louisiana grows good things—both above and below its rich soil.

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Oil has been the dominant force which has released this tremendous Louisiana energy.

This is the land of the Frio, the land of deep producers, the land of difficult completions.

The Oil Center Tool Company is proud to be a part of the development of this great State. O-C-T is a pioneer in well control equipment and its thorough research program has resulted in controls ideally suited for Louisiana problems of depth and pressure.

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Inset: A Louisiana Oil Landmark at Jennings.

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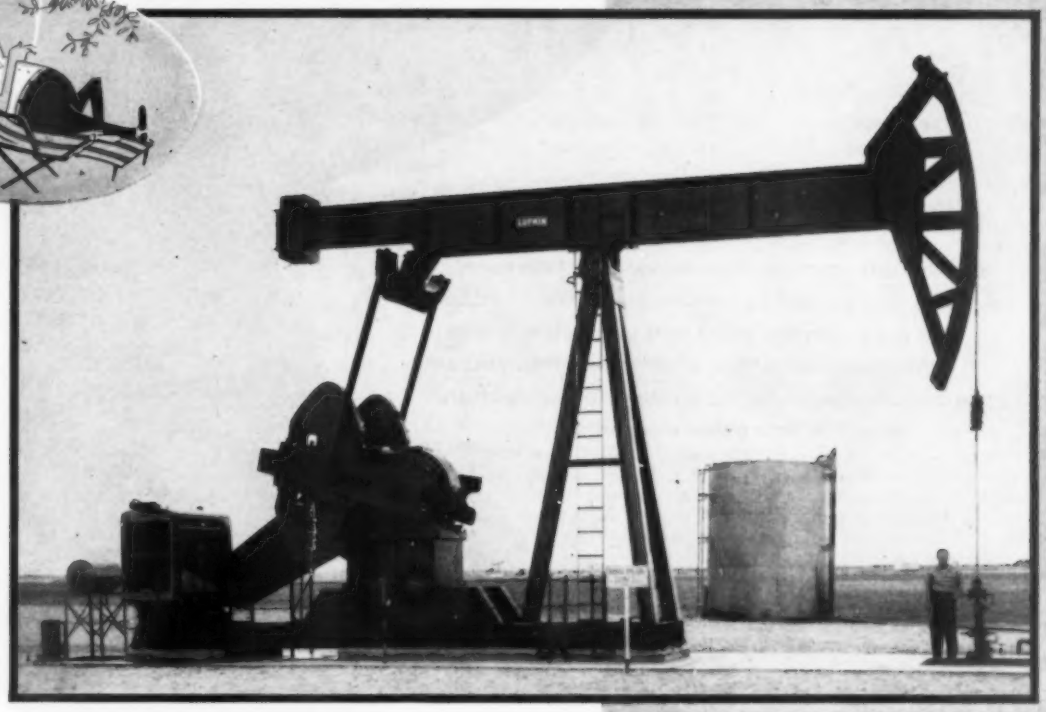

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*Mils penetration per year **Basis, 100% Activity

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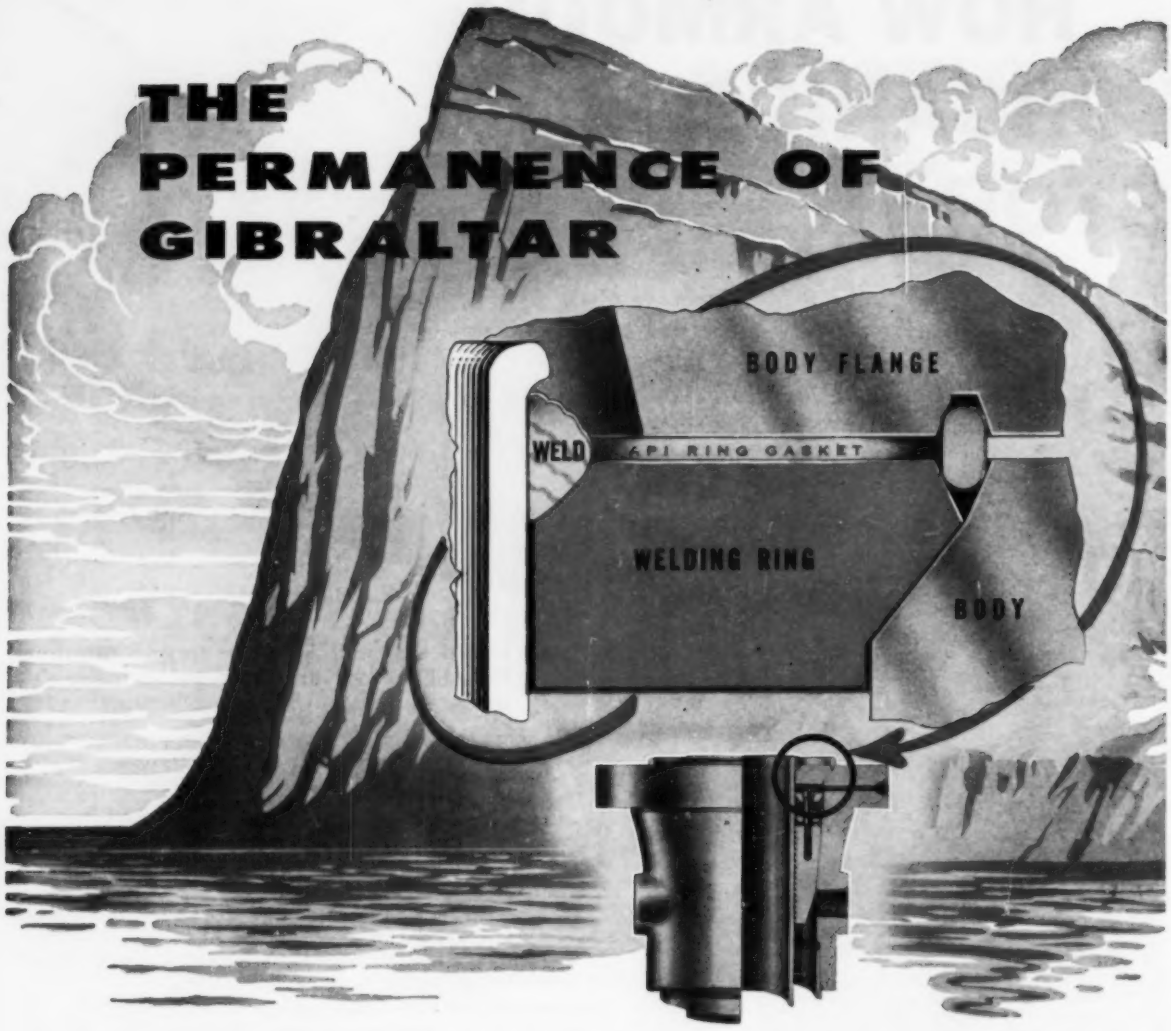

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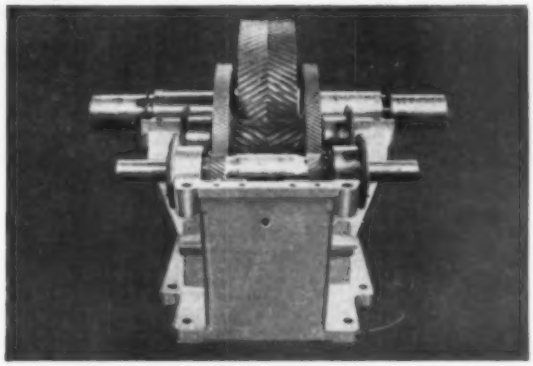

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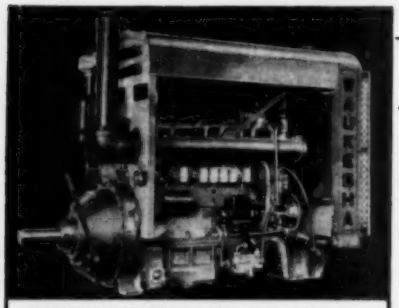

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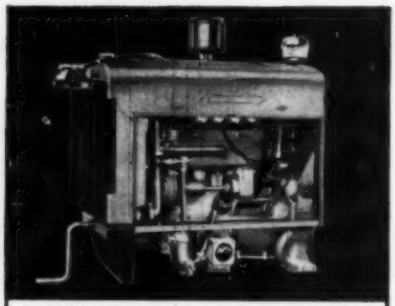

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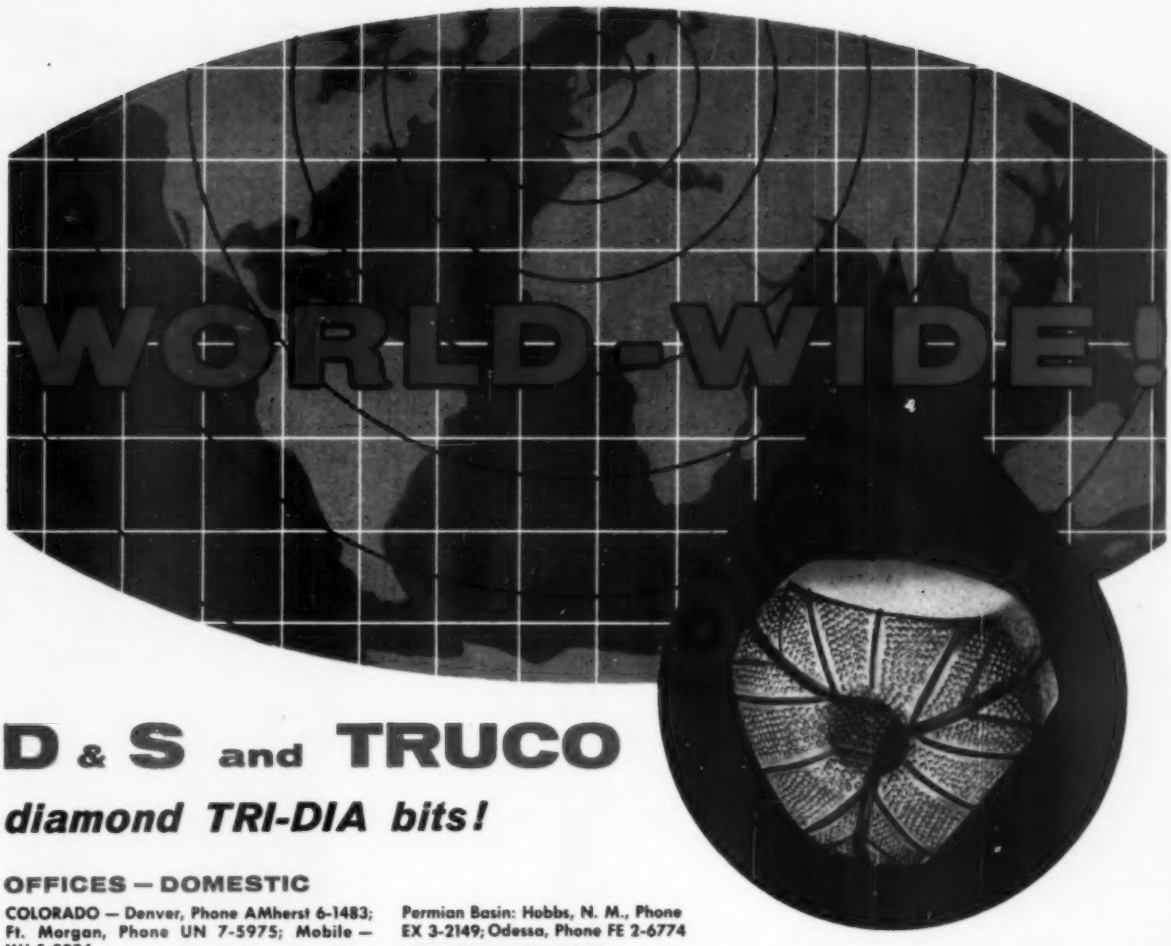

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Casing set at 22,919 ft...

West Texas Well Takes World's Depth Record

No. 1-EE University, Pecos County wildcat returns depth title to Phillips Petroleum Company and to West Texas. Well puts geologists in quandry

Darnell Peacock
Oil Editor
The Odessa American
Odessa, Texas

WITH LITTLE FANFARE, Phillips Petroleum Company passed the world's depth record of 22,570 ft, set casing at 22,919 ft — and plans to go deeper. The new record holder is the No. 1-EE University, located in rolling caliche hills about 13 miles east of Fort Stockton, in Pecos County, West Texas.

For the past three years, Richardson & Bass No. 1 LL&E, drilled in the marshlands of Plaquemines Parish of South Louisiana, has held the world's depth mark.

Phillips' well took the Texas' depth record April 28 of this year from Pan American Petroleum Company's No. 1-CS University drilled just seven miles from the No. 1-EE. Pan American's well went to 21,687 ft, where it encountered drilling difficulties and was plugged.

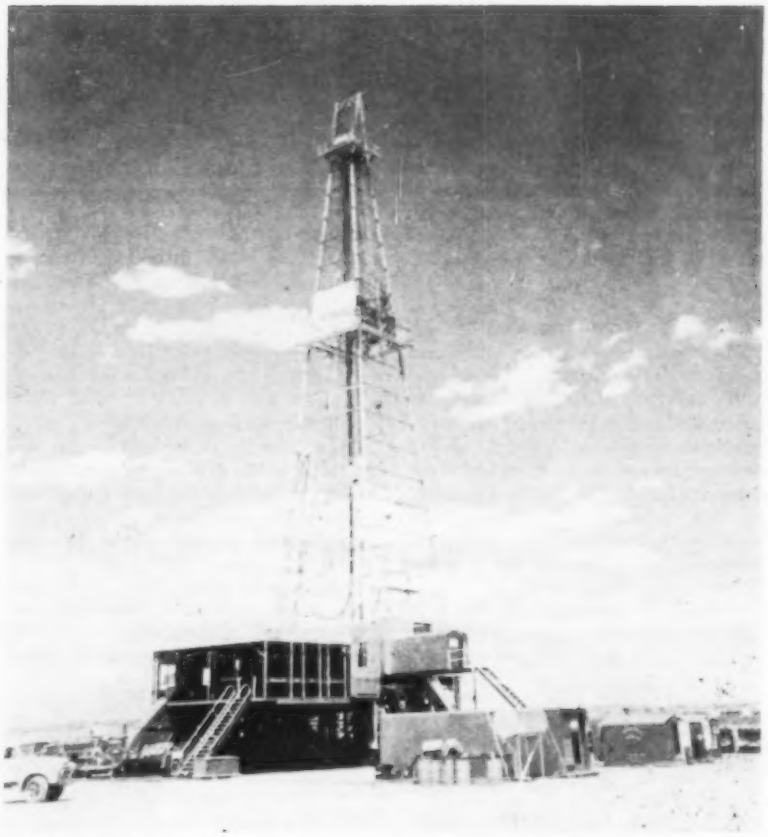
West Texas wells have held world's depth marks on two earlier occasions, first in 1935 with a 12,786 ft hole drilled by Gulf in Upton County, and later in 1945 by a well that Phillips drilled to 15,279 ft in Pecos County.

Phillips' No. 1-EE was spudded October 12, 1956. The record was broken at 8:25 p.m. on May 26. During a 24-hour period that the record was broken, 62 ft of hole was made. This was more than has been made in any similar period in the last several months. Cost of the well is estimated near $2,000,000.

Phillips is using its company-owned Rig 27 to drill the No. 1-EE, called by many "The prettiest rig in West Texas." Largely responsible for this title is Rig Supervisor J. R. Jackson, who has lived "on location" more than 19 months as the well was drilled.

Goal: 25,000 ft

When drilling began back in October 1956, the well was originally scheduled to go to 18,500 ft. Later it was changed to 21,000 ft, and finally to a 25,000 ft target. Some observers say that drilling will not be halted until difficulties develop or granite is reached.



Phillips' Rig 27 has been drilling the record well for 19 months at its location 13 miles east of Fort Stockton, Texas.

Objective: Basement

Original plans were to go to the Ellenburger (source of Texas' deepest production, in the Puckett gas field, 20 miles to the southeast) . . . but it seems Nature forgot to read the geology books.

The world's deepest well is being drilled in an area sometimes referred to as a geological enigma. It is located in the Sheffield Channel — a unique portion of the Permian Basin. Geologists admit they know little about the Channel; but it is more often than not agreed to be a buried feature connecting the Delaware Basin on the west to the Val Verde Basin to the southeast. During the last several months, major companies have poured millions of dollars into the area for oil exploration and have discovered:

1. No commercial oil or gas pro-

duction at the four-mile depth level.

2. The older formations, if found at all, are at extremely deep intervals.

3. The depth factor creates mechanical obstacles and resultant high drilling costs, partially explaining a reluctance for exploration in the area.

Evidencing the apparent sharp dip in the deeper formations is a comparison with the No. 1-EE or Pan American's deep dry hole with formation tops in the Puckett field, 20 miles to the southeast. This is the deepest production in Texas, the Ellenburger at around 15,000 ft.

As the Pecos County Phillips well reached the world depth record, geology was still uncertain. The objective was the Ellenburger, originally expected just below the Simpson.

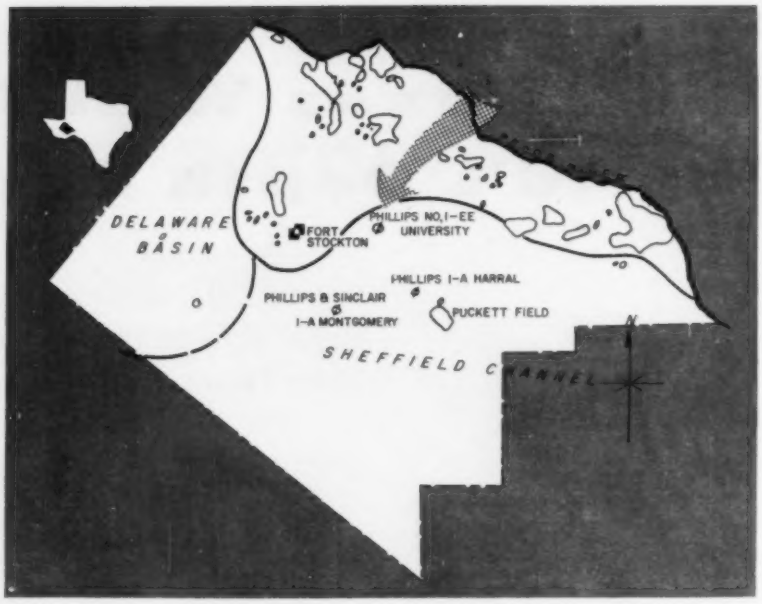
But because of what may be an overthrust, the Ellenburger and Simpson were encountered up the hole. Top of the Simpson was first found at 13,425 ft and the Ellenburger at 16,708 ft. The Simpson again was found at 20,520 ft. Soon after breaking the Texas depth record at 21,687 ft, a formation tentatively identified as Devonian was encountered. The Devonian was never found in Pan American's nearby deep well.

The Find: Promising Gas

What will the well yield other than geological information?

It's too early to determine, company officials say, but promising shows of gas production were logged on several drillstem tests of the Leonard and Wolfcamp at 8118-11,715 ft. Also encouraging was "a good drilling break" encountered at the four-mile depth level. However, this zone was not drillstem tested.

A total of 19 drillstem tests were taken at the well to a maximum depth of 17,331 ft.



World's deepest test, located in the Sheffield Channel. Phillips' No. 1-EE is near other deep tests, as indicated here. Deepest Texas producing gas area, the Puckett field, is also a "neighbor."

Equipment: Clean, 'Conservative'

Equipment on Phillips' Rig 27 is for the most part conventional and conservative. Drawworks used to drill the well was nominally rated by the manufacturer for 10,000 to 16,000 ft drilling. The drawworks has a 30 by 56¾-in. drum with 54-in. by 10-⅜-in. water cooled brake rims. Auxiliary is a 60-in. single rotor hydraulic brake connected directly to the drawworks' drum shaft.

Prime movers for both pumps and drawworks are three 635 hp 12-cylinder V-block engines. These deliver a total maximum of 1915 hp.

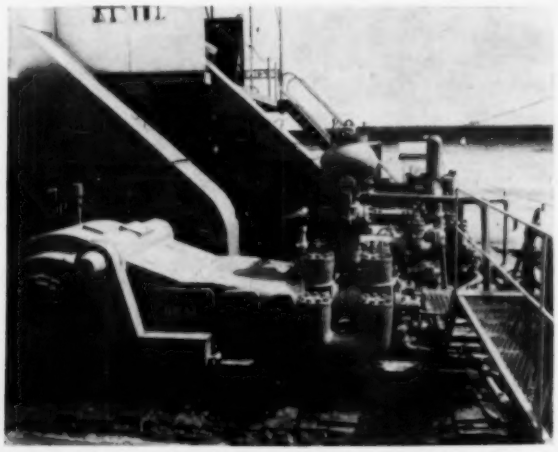
Main mud pump, with 1000 input hp, is compounded to drawworks engines. Auxiliary, also tied into main compound, is a 7¾-in. by 18-in. pump with a maximum input horsepower of 600. Main pump has 8½-in. liner with 16-in. stroke.

Derrick is standard-type, 136 ft high, has 32 ft base, and utilizes an 18-ft high substructure. Total load capacity is 1,000,000 lb.

The No. 1-EE's control equipment consists of two 10,000 psi test "bag" type blowout preventers and a 10,000 psi test hydraulic double cellar control gate blowout preventer.

All traveling equipment is 500-ton test.

Steel mud pits are used and drilling water is supplied from a well drilled close by. A mud logging unit has been an integral part of the rig's operation for several months.



Main mud pump, with 1000 input hp, is compounded to Rig 27's three 635 hp engines, as is the 350 input hp pump in the background.

Driller's console permits fingertip control of air operated engine throttles, engine clutches, pump drive clutches, master clutch, inertia brake, fluid drive scoops, and automatic feedout. At the brake is Driller C. J. Land.

Tapered Drilling String

Drilling below 22,000 ft required a tapered string, consisting of (from bottom to top): Seven 6½-in. drill collars, 327 joints of 4-in. Grade E, 14 lb per ft drill pipe; 110 joints of 4½-in. Grade E drill pipe, 16.6 lb per ft, and 280 joints of 4½-in. X-95, 16.6 lb per ft drill pipe.

Mud: Graphite

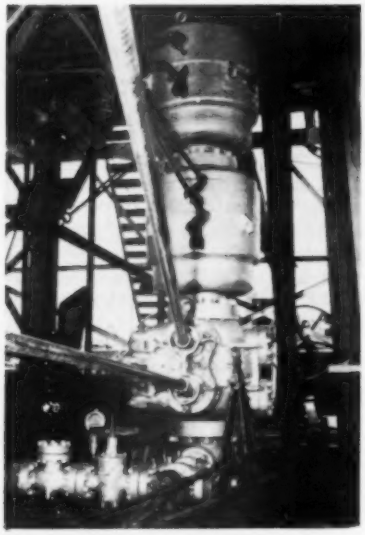
Mud now being used in the No. 1-EE is a low solids oil emulsion mud with graphite added. Components are diesel oil, an emulsifier, Driscose and graphite. Mud weight is 10 lb per gal, a 45-50 sec viscosity, with 5 cc water-loss maintained. Current circulation pressure is in the 1800 psi range.

Casing: More Open Hole

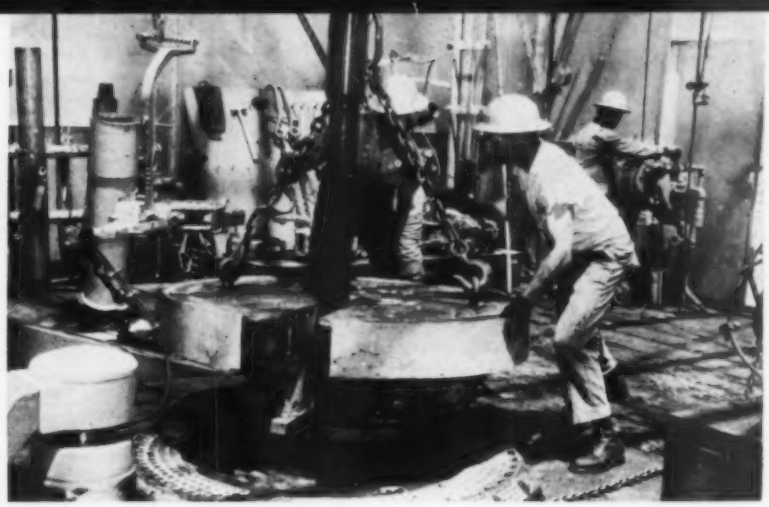
The wildcat had well over 11,000 ft of open hole when it broke the depth record. Surface pipe consisted of 1480 ft of 20-in. casing; 13⅜-in. string was set at 6020 ft; 9⅝ in. was set at 10,966 ft. A tapered casing string was set to 22,919 ft, consisting of 12,000 ft of 7-in., and remainder of 7⅝-in. Weight of the string is 714,000 lb.

Special Equipment: Shock Table

Most novel piece of equipment on Phillips' Rig 27, equipped especially for drilling the deep hole, is a hydraulic table to reduce shock loading of the drill pipe and reduce drill pipe fatigue. It serves as a cushion when drill pipe is being run, working on much the same principle as a shock absorber on a car. With the table, drill pipe is held in place by using two sets of elevators. One set fits atop the hydraulic table and replaces slips. This arrangement replaces drill pipes, which Phillips considers too abusive of highly brittle tensile strength (X-95) drill pipe. Air slips are used to handle other drill pipe in the 22,000 ft string. This table and double elevator handling system was engineered and designed by Phillips in Odessa.



Blowout control equipment makes a big package, even under Rig 27's 18 ft substructure. All preventers, all 10,000 psi test, are hydraulically controlled.



Hydraulic shock absorber table played an important part in safe handling of the long string of drill pipe. The table, for the purpose of eliminating shock loading, drill pipe fatigue, is a Phillips' innovation.

One of three drilling crews on the 1-EE: C. T. Webster, driller; E. J. Neslony, derrickman; B. R. Baker, floorman; L. D. Vick, motorman; L. P. Morales, floorman, and J. R. Jackson, rig supervisor. Jackson has called the rig "home" for almost 19 months at the one location.

Problems: Hard Rock, Deviation

Except for extremely hard formations and a deep fishing job, Phillips reports that the well has been drilled with a minimum of mechanical difficulties. As it reached the world depth record, about two feet of 8½-in. diameter hole per hour was being cut with tungsten carbide tipped tri-cone rock bits, each used for drilling from 120 to 160 ft of hole. More than 300 bits have been used in the well.

In addition to setting a depth record, the well also represents the deepest whipstock operation ever attempted in Texas.

A sidetracked hole was drilled at 19,966 ft after an unsuccessful fishing job developed in February at a total depth of 21,396 ft. Some 17,600 ft of drill pipe was dropped 3700 ft to the bottom of the well when a failure occurred as pipe was being run into the hole.

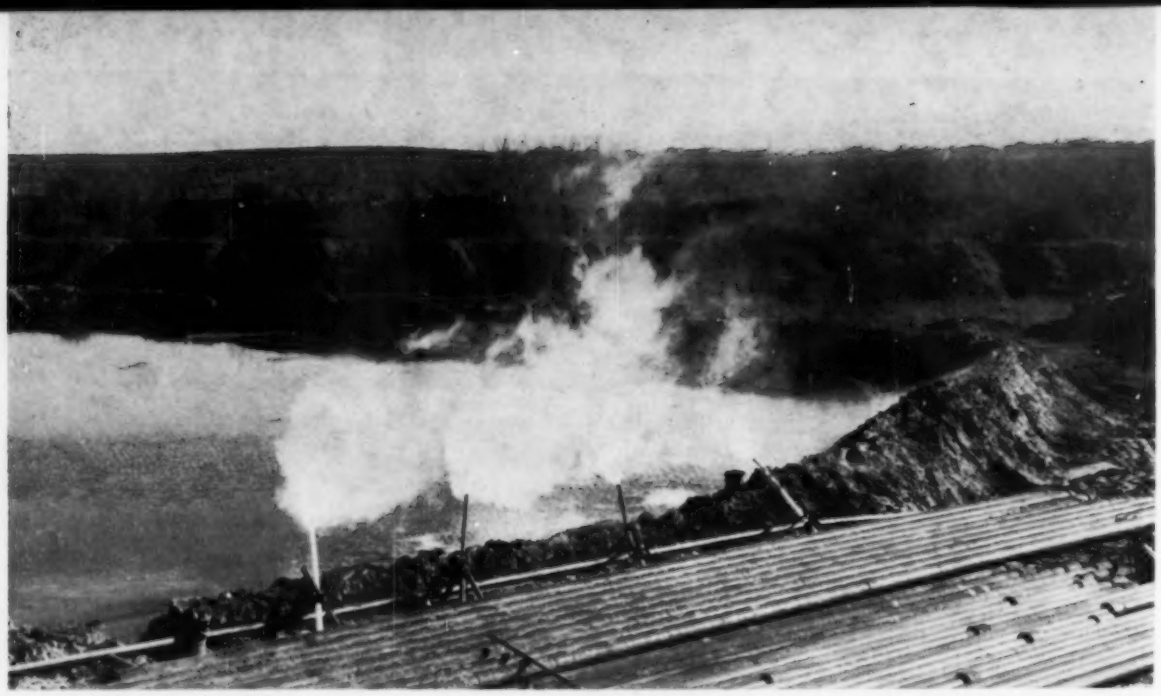
Prior to the fishing job, the company was beginning to experience hole deviation troubles. This amounted to 3¼ deg at 19,994 ft, jumping to 8 deg at 20,450 ft.

Deepest: How Long?

Two other significant deep tests are being drilled by Phillips in the immediate area of the No. 1-EE. They are the No. 1-A Harral, scheduled to 18,000 ft, and the No. 1-A Montgomery, with a 22,000 ft total depth target. Sinclair has a third interest in the Montgomery well, the Harral is a 100 percent Phillips' operation. Both rigs on these wells are capable of carrying a bit to depths similar to that of the No. 1-EE.

Although it is doubtful that these will attempt to break the new record, other wells drilled by other companies outside Texas indicate that the depth title is in mind. Officials of Howell & Howell, drilling the No. 1 Anadarko Basin in Caddo County, Oklahoma, have set a 24,000 ft contract depth goal. Also in Oklahoma, Shell Oil Company's No. 5 Rumberger, in Beckham County, is aiming at 23,000 ft.

... But the No. 1-EE University is not finished yet. ★ ★ ★



Four blowing flares signal a test of the oil industry's first quadruple well completion, in which four gas zones are produced from Magnolia Petroleum Company's Santa Cruz Farms, Well No. 8, San Carlos field, Hidalgo County, Texas.

Magnolia makes industry's . . .

P 459.6

FIRST QUADRUPLE COMPLETION

Lowell A. Murphy
Field Editor

Three parallel tubing strings and the casing-tubing annulus are used to produce four separate gas zones in this South Texas well

THE FIRST QUADRUPLE WELL COMPLETION in the oil industry has been made by Magnolia Petroleum Company to produce four different gas reservoirs through one well. The well is Magnolia's Santa Cruz Farms No. 8, located in the San Carlos field about 10 miles northeast of Edinburg, Texas, in Hidalgo County.

Magnolia considered several advantages in its decision to make the multiple completion. Such a technique permits the production of a gas zone which would not be large enough to warrant the drilling of a separate well. In addition, the completion allows immediate production from a fourth reservoir without waiting until one of the other three zones is depleted.

The well was drilled to a total depth of 7883 ft and plugged back to 7853 ft. A string of 7⅝-in. casing was set at 7875 ft and cemented with 500 sacks of cement. The four gas zones were then perforated at 7024, 7455, 7533, and 7629 ft. None of the gas zones was considered new since they had all been located previously in other wells.

Completion Equipment

The equipment used in this four-zone completion is the same as that developed for three-tubing-string completions. The fourth zone is produced through the annular space between the casing and the three tubing strings.

The major item of downhole equipment is a special triple string flow tube which was designed for three-zone, three-packer production hookup, producing each of three zones through a separate string of parallel tubing.

The hookup, as pictured in Fig. 1, consists of three different types of retainer production packers, one set above each of the three lower zones. The triple string flow tube seats and seals off in the upper packer. Extending below the triple string flow tube are two concentric strings of tubing. The outer tubing string extends into the middle retainer production packer with tubing seal nipples sealing off in the packer bore. The inner tubing string extends below this packer and seals off in the lower packer with tubing seal nipples.

The lower tubing string, which extends through the lower packer, is essentially full opening all the way to the surface. The outer two tubing strings end in annular spaces and are not large enough to permit running tools to the zones from which they are producing.

The upper zone is produced through the casing in the annular space around the three strings of tubing. The second zone is produced through the annular area between the bore of the upper

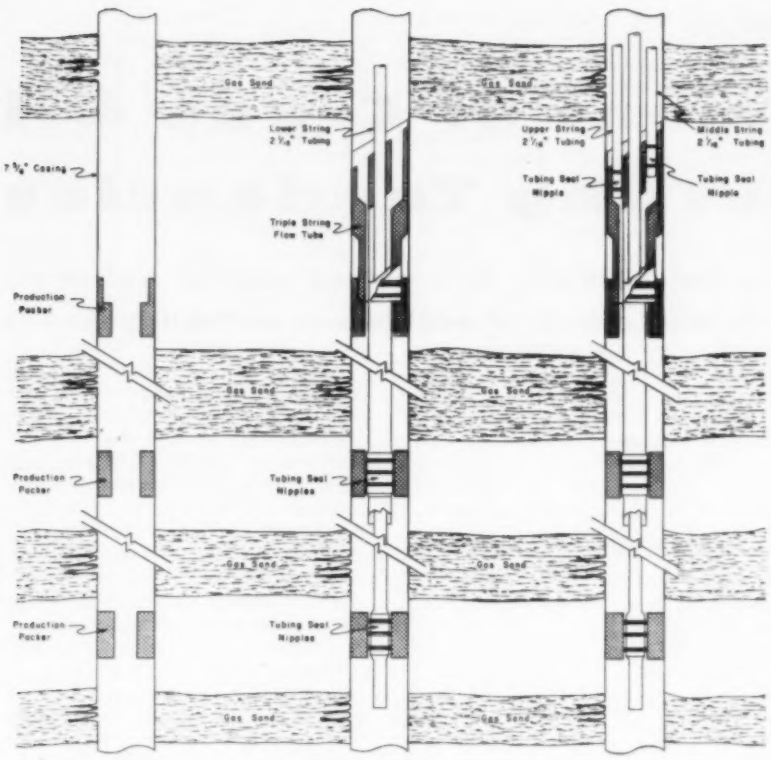


FIG. 1. **Diagram shows procedure** used in installing downhole equipment used in quadruple completion. (A) Three retainer production packers are landed and set between the four perforated gas zones. (B) Concentric tubing strings are made up below the triple string flow tube and the entire assembly is run in on the lower tubing string. Seal assemblies land and seal off in all three packers. (C) Upper tubing string and middle tubing string are then landed in the corresponding bores of the triple string flow tube. Upper zone produces through the casing-tubing annulus.

packer and the outside diameter of the outer concentric tubing string, into the flow tube, where it flows into the stabbed-in upper tubing string.

Production from the third zone flows through the annular space between the outer concentric tubing string and the lower tubing string. Within the flow tube, the flow is directed into the middle stabbed-in string of tubing. The production from the fourth zone enters the long string of tubing.

Running Procedure

After the three retainer production packers were landed and set, the outer concentric tubing string below the triple string flow tube was made up and set in the slips. This string contains tubing seal nipple, spacer nipples, and a full-opening, non-perforated production tube on its lower end.

The lower string of tubing was then made up and run through the tubing hanging in the slips. The string contains a production tube, tubing seal nipples, and spacer nipples. The seal nipples seal off in the lower packer.

The triple string flow tube was then screwed onto the lower tubing string and made up onto the outer concentric tubing string. The flow tube with the two concentric strings below it was run in on the lower string of tubing and landed on the upper retainer production packer, sealing off in the upper portion of the packer.

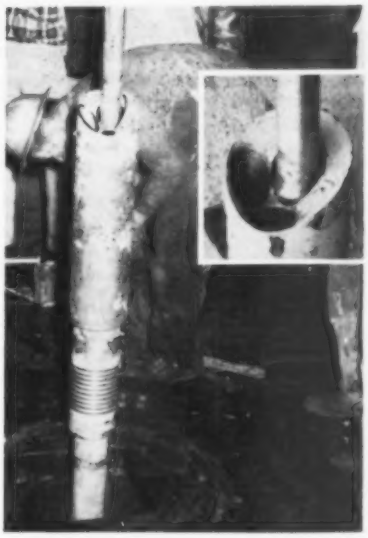
After the flow tube was landed and sealed in the upper packer, the middle string of tubing was made up with a locator type tubing seal nipple on the bottom end. The string was run in and seated in the corresponding bore of the flow tube.

The final and upper string was made up with a locator type tubing seal on the bottom end and landed in its corresponding bore of the flow tube.

The only difficulty experienced in running the tubing strings was in keeping the final string from passing between the middle and lower tubing strings already run to the flow tube. In this case, the string would be trapped between the other two and would not find its receptacle hole in the flow tube. In order to prevent this situation, an increased-diameter guide was placed in the final string near the bottom end of the string to prevent passage of the string between the other two.

Continued on Page B-27

Three-wing Christmas tree assembly controls production from lower three zones in the quadruple completion. The fourth zone is produced through the casing-tubing annulus.



This triple string flow tube seats and seals off in the upper of three packers and directs the flow of gas from the three lower producing zones. Inset shows upper end of flow tube with bores in which tubing strings are landed.

Seal assembly lands in middle of three packers. A concentric tubing string extends through this string and seals off in the bottom packer.

Capillarimetric method for . . .

Measurement of Crude Oil Wetting Tendencies

Used by physical chemists, this method may be extremely useful to determine effects of additives in wettability studies

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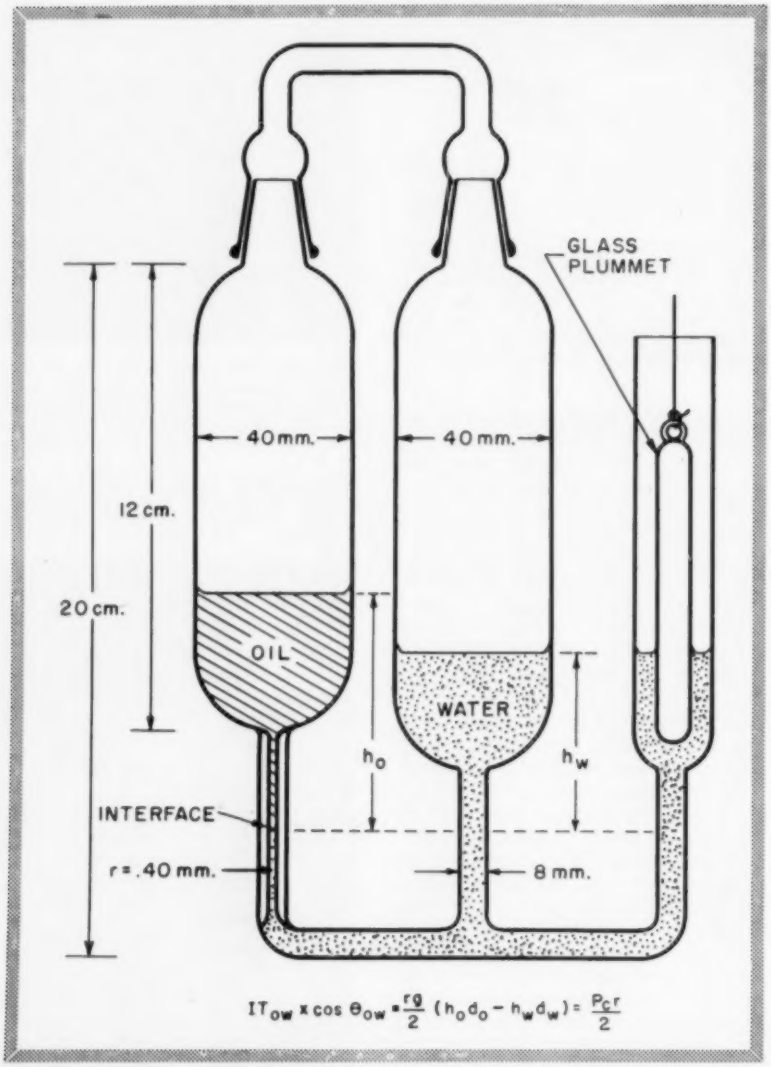

Interfacial tension capillarimeter used to determine crude oil wetting tendencies along with the formula for making calculations. (See Appendix for nomenclature) Dimensions are indicated in the schematic diagram of apparatus used.

PHYSICAL chemists have used an instrument in laboratory work that is applicable for determining effects of additives or treatments of crude oil wetting tendencies. It is now being developed as a method for screening reverse-wetting additives for water block removal. Known as the interfacial tension capillarimeter, it also should prove a definite means of evaluating the wetting tendencies of various crude oils.

The determination of wettabilities of petroleum reservoir materials is required for the development of proper selection of petroleum production methods. Much has been written on the subject and numerous methods have been used with limited success.

Imbibition[1] and the more general phenomena of capillary pressure afford the most direct approach to the measurement of wettability. The simplest type of capillary pressure observations involves the use of an interfacial tension capillarimeter. Such instruments, with various modifications, have been used extensively in some academic laboratories,[2,3,4] but have not found application in petroleum laboratories mainly because they do not produce separate values of either interfacial tension or contact angle. Actually, these quantities do not have independent significance in reservoir engineering, and the property of wettability they are intended to evaluate is given immediately by capillarimetric measurements.

How it works. In the interfacial tension capillarimeter, the force with which one liquid displaces another from a glass or quartz surface is balanced by that of the hydrostatic head developed. A circular capillary of constant bore is used so that the observation is one of capillary pressure (see Appendix-a). However, the capillary is used only for experimental simplification. The basic force measured is that with which one liquid displaces another from a solid surface — that is, in its simplest form, *preferential wettability* (see Appendix-b).

A convenient form of the interfacial tension capillarimeter is shown in the diagram.

Corrections for capillarity in the large arms are negligible for most purposes if the diameters are over 4.0 centimeters. The diameter of the capillary tube is selected to provide sufficient sensitivity without undue difficulty in cleaning and manipulation; a diameter of about 0.08 centimeters is convenient. The additional arm for the plummet permits equilibrium to be approached with either an advancing or receding contact angle.

Use of method. One use of the capillarimeter is illustrated by some results on a crude oil sample from Tatums field, Oklahoma, used to study the effect of high energy gamma irradiation on the wetting tendencies of an oil in contact with glass and water. This crude oil was described recently[6] and is a heavy, asphaltic oil. Results of this study are summarized in Table 1.

The change in the oil from one that displaces water from glass to an oil that is displaced from glass by water probably is due to the destruction of complex crude oil components by the gamma irradiation. This change is not shown by measurements of interfacial tension alone. These data demonstrate the ease and definitiveness with which preferential wettability may be determined with the interfacial tension capillarimeter.

Limitations. The interfacial tension capillarimeter has the limitation that the solid surface usually is glass. Although this surface can be varied slightly, a uniform capillary in reservoir rock is obviously impracticable. On the other hand, virgin core samples are virtually unknown and imbibition tests using natural core samples cannot be performed with many viscous crude oils.

Practical applications. The capillarimetric method is applicable for determination of the effects of additives or treatments on crude-oil wetting tendencies. For example, it is being developed as a method for screening reverse-wetting additives for water-block removal. The method also should prove a definite means of evaluating the wetting tendencies of various crude oils.

TABLE 1. Effect of Gamma Irradiation on Displacement Energy ($IT_{ow} \cos \Theta_{ow}$) of Tatums Crude Oil.

Irradiation (million roentgens)	Displacement Energy[a] (dynes/cm)	Interfacial Tension[a] (Pendent Drop, dynes/cm)
0	— 22[b]	25
100	+ 5	24
200	+ 25	25

[a] Average values.
[b] Negative values indicate that the glass is preferentially oil-wet in this system; the capillary would spontaneously imbibe oil.

Appendix

[a] $P_c = (2\ IT_{ow} \times \cos \Theta_{ow})/r$, where P_c is the capillary pressure, dynes/cm²; r is the radius of the capillary, cm; IT_{ow} is the interfacial tension at the oil-water interface, dynes/cm; and Θ is the function called "contact angle," usually measured through the aqueous phase.

[b] The energy with which one fluid displaces another from a solid surface has been expressed by the equation: $IT_{ow} \times \cos \Theta_{ow} = IT_{os} - IT_{ws}$, where the symbols are as above, and the subscripts os, ow, and ws, refer to the oil-solid, oil-water, and water-solid interfaces. Although this is a logical and generally accepted equation,[5] it has not been corroborated experimentally because of the inability to measure interfacial tensions at a solid interface.

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Tubing. The three strings of tubing used in this multi-zone completion consisted of 2 1/16-in. OD tubing having a wall thickness of 0.156 in. The "super-slim" pin and box tubing connection uses a Teflon seal ring designed for high pressure completions. The Teflon ring seals off both internal and external pressures since the seal ring becomes extruded over both sides of a retaining groove machined into the male member of the joint.

All tubing joints were individually tested with a hydraulic testing unit to 4500 psi.

A sliding sleeve valve was installed in the upper and lower tubing strings. These valves are designed to be opened with wireline equipment and provide a means of circulating mud to kill the well without having to unseat the packer.

For protection against gas erosion, or erosion by sand which might be produced from the upper perforations, rubber sleeves were placed over the tubing string opposite the perforations.

Well Head. The well head installed on Magnolia's quadruple completion was specially fabricated for the job.

Christmas tree assembly is lowered into place over casing head assembly which has side outlet for production from upper gas zone.

Master valve for each of the three tubing strings in the well head is a 1¾-in., 6000 lb test, screwed-end valve. The four wing valves, three on the well head and the fourth on the casing head for production from the annulus, are 2 in. by 1 in., 6000 lb test, flanged-end, venturi type valves. The "O"-ring seal hanger couplings are grooved for back-pressure valves.

All connections and seals in the well head were tested to 5000 psi.

Production

Four-point back-pressure tests have been made on the well in conformance with Texas standards. Absolute open flow potentials resulting from these tests are as follows:

7024-7030 ft: 8800 Mcf gas per day
7455-7495 ft: 36,000 Mcf gas per day
7533-7560 ft: 7400 Mcf gas per day
7629-7649 ft: 6900 Mcf gas per day

Magnolia engineers expect no troubles in producing the four zones simultaneously. Previous experience in the field shows that there should be no problems stemming from sand production and that the gas is not corrosive.

Acknowledgment

The author is grateful to the Magnolia Petroleum Company for permission to obtain and publish this article, and to Magnolia's Houston Division engineers and supply company engineers for data and photographs used in this report.

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Russian Record Claim Refuted

In drilling over 32 miles of hole with one rig in 1957, Garvey Drilling Company also punches a hole in Russia's claim to a world footage record

LEAVE IT TO THE RUSSIANS to make claims of world's records. But leave it to American drillers to make footage.

Russia has claimed that a Soviet drilling crew set a world record during 1957 by making 128,572 ft of hole in one year with a single rig, "exceeding an American mark of 125,465 ft established in 1956." (See *"What's Doing in Drilling,"* THE PETROLEUM ENGINEER, April 1958).

"We don't claim any world record," replies Claude W. Bard of Garvey Drilling Company, Great Bend, Kansas, "but we had three rigs that drilled more footage during 1957 than the Soviet crew cited in *Pravda*."

Garvey Drilling Company's Rig. No. 17 which, along with two other of the company's rigs, exceeded the footage drilled by a Russian rig and cited by Soviet sources as a world's footage record in 1957. No. 17 drilled a total of 169,924 ft of hole to compare with Russia's "record" of 128,572 ft drilled with one rig.

And further, Bard reports, three Garvey rigs drilled more footage during 1956 than the figure *Pravda* quotes as the 1956 American record; more, in fact, than the Russian rig made for its "world record" last year.

The Soviet crew was drilling in the Pre-Azov Oil Trust, on the Kuban Steppe near Krasnodar. *Pravda* reports that the crew completed 21 wells in the 12-month period. The Russian newspaper adds that another crew in the same area also "broke the American record," completing 22 wells and making 128,493 ft during 1957.

Garvey Rig No. 17, drilling in the Julesburg Basin of Nebraska and Colorado, made 169,924 ft of hole during 1957, in completing 27 wells. Garvey Rig No. 19 made 159,915 ft, and Rig No. 16 made 144,289 ft, both working in the Julesburg Basin.

During 1956, Rig No. 17 made 158,296 ft of hole in completing 27 wells, while No. 16 made 147,265 ft on 26 wells, and No. 18 made 138,202 ft on 26 wells. So Bard, vice president and general manager for Garvey Drilling, takes great satisfaction in the improved efficiency of the company's rigs. The record of beating Russia's best drilling crews comes as a by-product.

"Of course we hadn't given any thought to setting a drilling record. But when we saw the Russian claims, we brought out the 1956 and 1957 files to see how our rigs had done."

The company's charts show that Rig No. 17 made an average of 632.43 ft per drilling day during 1956. The same rig, during 1957, drilled an average of 768.89 ft per drilling day. Similar comparison for No. 16 shows an average of 663.35 ft in 1956, and 683.83 ft in 1957. Rig No. 18 made 593.14 ft during 1956, compared with No. 19's 667.25 ft during 1957. The overall daily drilling average of the company's three most productive rigs for 1956 was 629.64 ft, while the three leaders for 1957 averaged 706.65 ft.

How do the other variables compare? Rig No. 17's record for 1957 included 766 miles of rig moving, or an average of 28.37 miles per rig move. One move ran up to 110 miles; six were for 40 miles or more. The rig was active 289 days, with 221 days spent in actual drilling, and 68 days of "company time" for logging, drill stem testing, etc. "Actual drilling days" include maintenance time and "WOC" time. No. 17 completed a 5325-ft well in 5⅓ drilling days. Its deepest well of 1957, 7290 ft, required 15 drilling days due to a fishing job, but a 7180-ft well required only 8⅔ days. **The rig's average depth of wells spudded and completed during 1957 was 6293.48 ft. This compares with 6122.47 ft per well on the Russian record of 1957.**

Comparing No. 17's record of the two years, statistics show that the crew had to push in 1957 to beat the 1956 record. During 1956, the rig was active 311⅔ days, with 250⅓ days of drilling (29⅓ more days of drilling than in 1957). The average rig move during 1956 was comparable (25.31 miles) and the average well depth was somewhat less (5887.27 ft).

All of the Garvey rigs involved in the comparison are identical in equipment. Derricks include 97-ft masts with 300,000-lb capacity; a 5-ft substructure with 500,000-lb capacity; a 3-sheave traveling block with 100-ton capacity; and a hook with 100-ton capacity. The drawworks include a 500 hp engine, two 450 hp diesel engines and a 17½ in. rotary table. The units have 7½ in. by 14 in. power pumps.

Drill pipe is 7000 ft of 3½ in. OD, 13.30 lb, grade "E" drill pipe with 4¾ in. OD tool joints. Drill collars on each rig include twelve 4¾ in. OD by 2¼ in. ID by 30 ft collars and four 6-in. OD by 2¼ in. ID by 30 ft collars. Each rig operates with a regular 4-man crew.

Bard points out that if a company were to set out to establish a "world record" for a rig's total footage for a year, it would be relatively simple to run the figures on up. Rig No. 17 was active 289 days during 1957. If the rig's schedule of work had been planned to keep the unit busy more days, it would of course have made more feet of hole during the year. Rig No. 17's achievement — just short of 170,000 ft, came in the course of normal operation. Some of the wells were drilled for Petroleum, Inc., the production arm of the Garvey organization. The others were drilled on contract for other companies.

Bard and his engineers concluded that the Russians aren't using their much-vaunted "turbo-drill," if their best rig made only 128,572 ft of hole in a year.

"Our American methods seem to be holding their own, anyway," Bard said.

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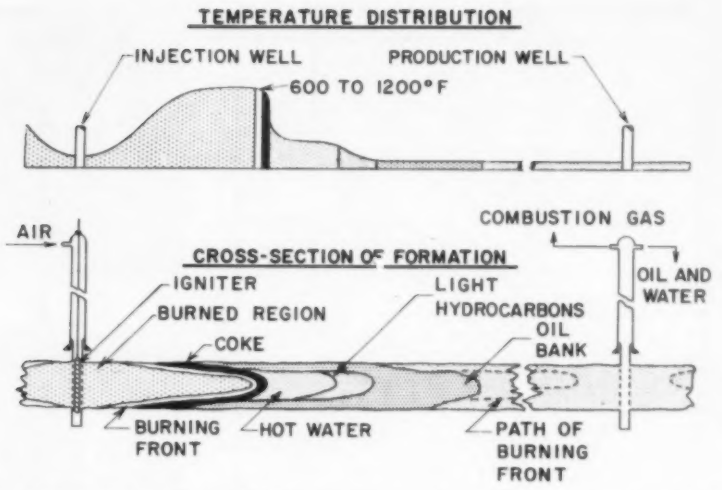

Mechanisms of the in-situ combustion process are demonstrated in this cross-sectional schematic drawing of the formation between an injection well and a producing well. Top diagram shows temperature distribution and location of burning front.

Recent progress in . . .

Oil Recovery By In-Situ Combustion

James S. McNiel, Jr. and Jon T. Moss
Field Research Laboratory, Magnolia Petroleum Company, Dallas, Texas

Some basic design factors including (1) air requirements, (2) compressor requirements, and (3) oil recovery and production rates. Score on process to date: 7 tests concluded; 9 projects underway; and 4 more in planning stages

SPIRALING COSTS of locating and producing new deposits of liquid fuel in recent years have given rise to a keen re-appraisal of secondary recovery methods. In addition to waterflooding and gas repressuring, many unusual ideas for the release of unrecoverable oil have been given the criticial eye by teams of scientists in production research laboratories throughout the world. Studies in the field and the laboratory confirmed a logical suspicion: Displacement by water or gas of all low-gravity and many intermediate gravity crude oils was an extremely slow and ineffective process at low temperatures (those existing in reservoirs which produced such crude oils). The problem of oil recovery in these cases

Presented at the Eleventh Oil Recovery Conference sponsored by the Texas Petroleum Research Committee, at Austin, Texas, May 8-9, 1958.

Field tests of in-situ combustion extend widely across the U. S. as this map indicates. Black dots show locations of proposed, active and completed in-situ oil recovery projects.

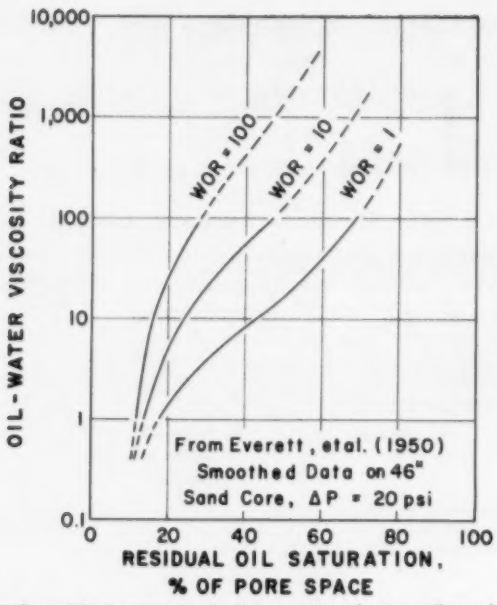

FIG. 1. **Displacement of oil by water** showing effect of viscosity ratio. (From published data on artificially consolidated sandstone core about 4 ft long. Data smoothed and extrapolated).

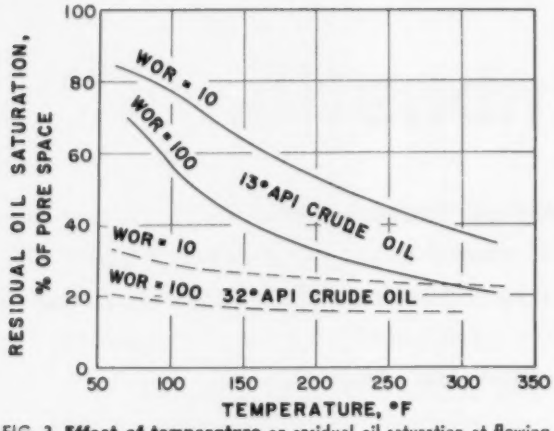

FIG. 3. **Effect of temperature** on residual oil saturation at flowing water-oil ratios of 10 to 1 and 100 to 1. Note marked effect in displacement efficiency of temperature on low-gravity crude oil.

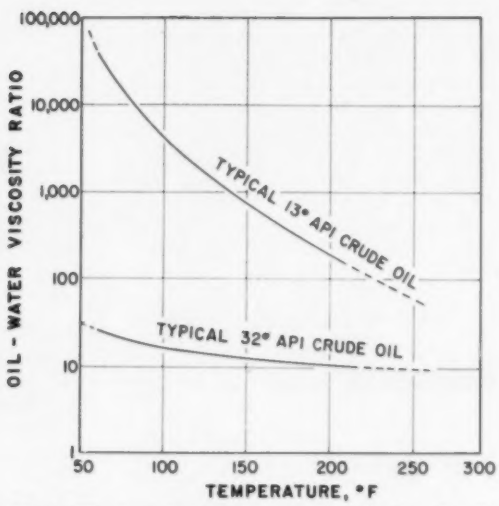

FIG. 2. **Effect of temperature** on the oil-water viscosity ratio for one low-gravity and one intermediate gravity crude oil.

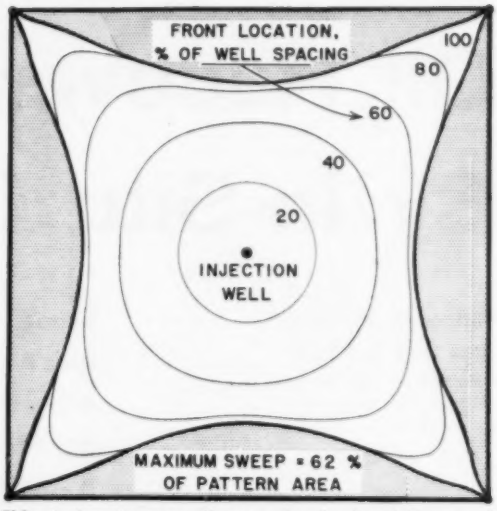

FIG. 4. **Areal sweep diagram** for developed 5-spot well pattern. Mobility of air behind the burning front is very high compared to the mobility of gases in the reservoir ahead of the burning front. Ratio of these mobilities approaches infinity.

seemed to warrant two methods of attack, involving either (1) new displacing fluids, or (2) elevated reservoir temperatures. These lines of investigation led to the "new" processes of solvent flooding and thermal recovery. Over a period of several years a practical procedure for applying heat to a reservoir was developed which appeared to incorporate mechanisms of both solvent and thermal methods. This method has been generally referred to as "In-Situ Combustion."

The basic idea of this method is not really new. J. O. Lewis, in Bureau of Mines Bulletin 148 issued in 1917, 41 years ago, wrote: "Of the oil retained in the sand after a well has reached economic exhaustion under customary production methods, part is retained so tightly by capillarity in the finest pores as well as by adhesion to the surface of sand grains that its removal seems to be possible only by using heat or solution." The idea of "underground heat generation process" was introduced in the Soviet Union,[1,8] and a number of unsuccessful efforts to initiate and maintain a moving combustion front are documented[8,9] in the literature of the USSR. However, only during the past six years have properly engineered field tests been conducted, and progress on in-situ combustion methods has been rapid since 1952. This was the year that Magnolia and Sinclair engineers, each group working independently only some 300 miles from the other, initiated movement of combustion fronts in pattern-type experiments after several years of preliminary tests.[5,7] Since that time, field experiments have been conducted or planned by a large number of operators.

PRINCIPLE OF HEATING TO INCREASE OIL RECOVERY

One question that arises in the evaluation of thermal recovery processes is: "How does a change in temperature bring about additional oil recovery?" To answer this question, reference is made to Fig. 1, 2, and 3. Fig. 1 represents published data[3] on the displacement of oil by water from an artificially consolidated sandstone core about four feet in length. The data have been smoothed and extrapolated to show the effect of viscosity ratio. Fig. 2 shows the effect of temperature on the oil-

water viscosity ratio for one low-gravity and one intermediate gravity crude oil. By assuming that a change in temperature has no gross effect on the displacement mechanism (i.e., that changes caused by alteration of wettability and interfacial tension are small compared to those caused by viscosity reduction), viscosity-temperature data of Fig. 2 can be combined with the displacement data of Fig. 1. This has been done in Fig. 3, which illustrates the effect of temperature on residual oil saturation at flowing water-oil ratios of 10 to 1 and 100 to 1.

The most interesting features of Fig. 3 are the distinct differences between intermediate-gravity and low-gravity crude oils in residual oil saturation at low temperatures, and the very marked effect of temperature on the efficiency of displacement of the low-gravity crude oil. It should be added that if temperatures are sufficiently high, leading to complete vaporization of the interstitial liquids, the interface between oil and water might be expected to disappear. Under these conditions, the microscopic displacement efficiency should approach that effected in a miscible phase process except for the amount of oil converted to coke by cracking.

Economic heat source. Recognizing by the above example that the application of heat should greatly increase recovery under some conditions, one is faced with the problem of selecting the most economical method of heating an oil reservoir. A method which utilizes an inexpensive supply of thermal energy and which supplies it to the displacement front with negligible loss in transit should, of course, have maximum effectiveness. The only way of fulfilling both of these conditions, as far as we know, is to burn a small portion of the in-place oil and create a moving combustion front. The in-situ combustion recovery process is a logical culmination of research in secondary recovery and appears to be a reasonable solution to the problem of recovery from reservoirs containing heavy crude oils.

MECHANISM OF IN-SITU COMBUSTION

The in-situ combustion process is much more complicated than mere displacement of oil by water. While our understanding of detailed mechanisms of the combustion and displacement has improved greatly as the result of intensive study during the last 10 years, many questions still remain unanswered. The process can be described in a qualitative way by reference to the schematic diagram on the first page of this article.

Downhole ignition. After injecting air for a relatively short time to establish a continuous gas phase between the injection and production wells, the formation is ignited at the injection well. Several methods of ignition have been used. Briefly, these are by downhole electrical heaters, downhole gas burners, and chemical methods in which a readily oxidizable chemical such as phosphorous is spotted in the well bore. The use of a mixture of steam, exhaust combustion gases, and free oxygen has also proven successful.[4,14]

Propagation of heat. During continuous air injection after ignition, a slowly moving burning front advances toward the producing wells. The crude oil immediately ahead of the high-temperature burning front is carbonized to produce a coke-like deposit on the sand. This deposit constitutes the principal fuel for the process. Left behind the burning front is hot, clean sand which is effectively utilized to heat the injected air before it reaches the burning zone. Movement of a continuous burning front, by its very nature, results in virtually complete removal of all reservoir liquids from that part of the formation swept by the front. As might be expected, *continuous propagation of the burning front in all directions appears to be the most critical part of the operation.*

With air as the oxidizing agent and with fuel concentrations of 1 to 2 weight percent of the reservoir rock, combustion zone temperatures usually reach 600 to 1200 F. In addition to the transfer of heat from the combustion front by conduction, an appreciable amount of heat is carried forward into the oil sand region by the water of combustion and by the formation water vaporized at the burning front. The resulting steam, upon condensation, provides a hot-water sweeping action. Ahead of this zone, the light hydrocarbons evolved by distillation and mild cracking of the oil at the combustion front blend with formation oil to increase its mobility.

Oil bank formation. The creation of an oil bank downstream of the burning front is probably next in importance to the maintenance of combustion. This bank represents a zone of high oil saturation and results primarily from the displacement by the burning front of oil from the region swept by the combustion front. The bank tends to grow in length, and as it approaches a producing well, a substantial increase in the oil production rate occurs. All of these mechanisms function simultaneously and complement one another. Consequently, oil is produced at not only greatly increased rates but also in greater total amounts.

Variation in basic process. Sinclair in their early field tests[5] injected mixtures of air, natural gas, and exhaust gases. Worthington and Forest Oil Company reported[4,14] the injection of steam, exhaust combustion gases and free oxygen, and Ramey, in a discussion[5] of Sinclair's field test, listed other possible injection mixtures. All of these processes, however, are quite similar and depend, basically, on moving a high temperature zone through the formation.

Extent of burn-out. Experiments with inert gases along with highly complex heat-transfer calculations indicate that breakthrough of the burning front

Jon T. Moss *attended the Texas Agricultural and Mechanical College during 1942 and 1943. After serving two years in the U. S. Army Air Force, he attended East Texas State Teachers College in 1946 and received his BS degree in chemical engineering from Texas A & M in 1949. From 1949 to 1952 he was employed by the Carter Oil Company as an engineer in their production department. He joined the Magnolia Field Research Laboratory in 1952 and was instrumental in conducting field experimentations on in-situ combustion. At the present time, he is a senior research engineer engaged in the correlation of data concerning oil recovery by thermal methods.*

James S. McNiel Jr., *graduated from the University of Texas in 1943 with a BS degree in chemical engineering. After a two-year hitch as an aircraft pilot in the Army Air Corps, he returned to the University of Texas, completing work for MS and PhD degrees in chemical engineering in 1949. Since that time he has been with Magnolia Petroleum Company's Field Research Laboratory and for the past nine years has been engaged in oil production research, principally on problems associated with drilling fluids, oil well cements, well completion and stimulation, and thermal recovery processes. His present assignment is group leader in charge of thermal recovery research.*

into producing wells is not necessary to achieve high oil recovery. Traverse of the burning front over about three-quarters of the distance toward the producing wells might be sufficient; subsequently, by conduction alone, elevated temperatures would reach the remaining distance. From this method of "partial burn-out," oil production might continue for a period of from several months to more than a year after combustion is stopped. Injection of exhaust combustion gases, water, or other fluid heat carriers would, of course, increase the rate of heat transfer to the unburned region.

OPERATING VARIABLES

Rate and direction. The in-situ combustion drive has been shown to have certain basic similarities to other types of drive mechanisms such as gas injection or waterflooding. The unusual aspect of a combustion drive is the presence of a moving heat front. To achieve maximum oil recovery by this means, the heat front should be carefully controlled both as to its rate and direction of movement. Unfortunately, efforts to exercise control over the direction of burning have not been uniformly successful, but knowledge of the controlling variables has become much more complete and systematic in the past few years, and progress toward better control of these aspects of the process can be expected to continue.

Laboratory studies. The role of laboratory work in systematizing knowledge of operating variable is difficult to over-emphasize. Just as laboratory flood pot tests are useful in evaluating and studying the effects of water-flood operations, laboratory combustion tube studies provide much useful information for in-situ combustion. The application of laboratory experimentation on in-situ combustion was discussed briefly in an earlier paper.[7] More recently, Martin and co-workers at Continental[10] authored a paper showing how tube experiments are used in studying process variables associated with the combustion drive. The potentiometric model is another laboratory tool which, for a number of years, has been useful to reservoir engineers. This device helped clarify some important design considerations for specific pattern geometries by permitting the application of laboratory results derived from linear flow systems to field flow systems.

Fuel Consumption

One of the most important results obtained from laboratory experiments is the indication of the amount of residual fuel deposited on the sand by the oil. These data are usually expressed as pounds of fuel per 100 lb of sand and then converted to pounds per cubic foot of formation by multiplying by the bulk density of the formation.

We have experimented with a number of different crude oils and found that the fuel deposited usually ranges from 1 to 2 lb per 100 lb of sand. Generally, the heavy, viscous oils seem to leave higher fuel deposits than do light, high-gravity oils. Some of the factors which may affect the fuel deposition characteristics of a crude oil are burning-front temperature and rate of advance, oil viscosity, oil composition, pressure gradient, composition of oxidizing gas, and specific surface area of the formation rock.

Oxygen Utilization and Unit Air Requirement

The in-situ combustion process is unlike common industrial combustion processes (such as those used for generation of power) in technical as well as in economic principle. In most industrial processes, combustion air is essentially free, and the cost of fuel is the significant economic factor. Conversely, in underground combustion, where the fuel is an almost worthless carbonaceous residue left by crude oil vaporization and cracking, the primary operating expense is the cost of compressing air.

An important variable affecting air requirement for a given oil sand is the efficiency of oxygen utilization. Often, laboratory tests conducted at high air flux rates to insure active combustion are characterized by poor oxygen utilization, or apparently poor combustion efficiency. In the field, where the flow of air to the burning front is slower than in most laboratory tests, at least when the combustion front is at a considerable distance from the injection well, better utilization of oxygen might be expected. Indeed, a typical anlysis of injected and produced gas from Worthington's test indicated oxygen utilization of more than 90 percent during a period of active combustion, even when the injected gas was low in oxygen; most of the oxygen showed up in the produced gas as a carbon dioxide. At the same injection rate, a gas richer in oxygen would be expected to cause a higher burning front temperature and presumably even better oxygen utilization.

Air used for combustion of a cubic foot of formation, designated as the unit air requirement, can be estimated from results of laboratory combustion studies. Since this quantity depends on combustion efficiency and cannot be expected to be the same in the field, where geometry and flow rate are quite different, it is convenient to subtract excess air from the total requirements and express the air requirement as that needed for 100 percent oxygen utilization. For many oils, this figure has been found to range from about 200 to 400 std cu ft per cu ft of oil sand.

Areal and Vertical Sweep

Aronofsky and Ramey[1] have shown that the areal sweep efficiency in a frontal displacement process varies with the mobility ratio (ratio of mobility of displacing fluid to that of displaced fluid). Considering the process of in-situ combustion, the mobility of air behind the burning front is very high compared to the mobility of gases in the reservoir ahead of the burning front. The ratio of these mobilities, therefore, approaches infinity. For developed five-spot operations, the areal sweep of the burning front at breakthrough into production wells is about 62 percent of the pattern area, assuming uniform permeability within the pattern and infinitive mobiltiy ratio. Fig. 4 shows the configuration of the burning front at various locations as it moves outward from the injection well. These locations are conveniently expressed as a percent of the injection to production well spacing.

In addition to limitations on areal sweep, such factors as gravitational effects, quenching caused by heat losses to over and underlying strata, and incomplete ignition of the sand face at the injection well may limit the vertical extent of a burning front. For example, in Magnolia's three-well Oklahoma test, burning was confined to the upper 8 ft of the 20-ft oil sand. At present, no general conclusion can be drawn concerning vertical sweep. Conventional techniques used for predicting sweep in two dimensions appear to be inapplicable, and novel approaches will undoubtedly be required. Since vertical sweep is a variable perhaps equal in importance to areal sweep, research on methods to establish reliable design information appears to be a fruitful field.

Minimum Rate of Burning Front Advance

A variable of major importance in the combustion process is the lower limit of frontal advance rate that can be maintained without quenching of the flame (active combustion). Knowledge of this quantity would be useful in the design of combustion operations and in evaluating economics of the process, for it establishes the minimum air injection rate for propagation of a burning front and fixes the limits on burned area for a specific type of recovery pattern and for specific compressor capacity.

Burning front advance rate. The minimum RBFA (rate of burning front advance) naturally depends on the

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PRODUCTION APPLICATIONS

SINGLE ZONE Normal Completion

SINGLE ZONE Permanent Type Well Completions

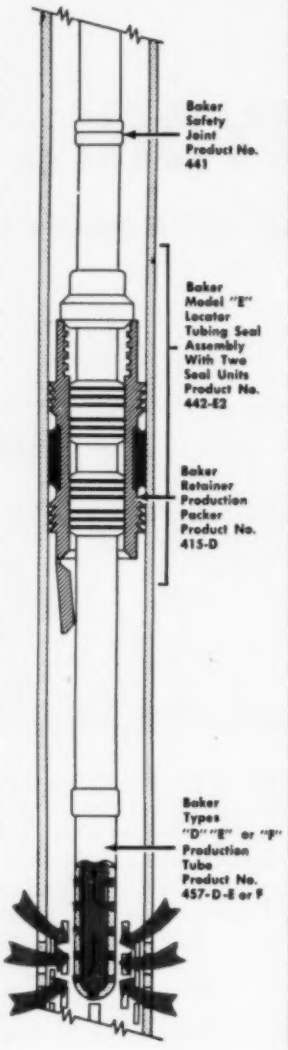
Baker Retainer Production Packer Product No. 415-D

FEATURES

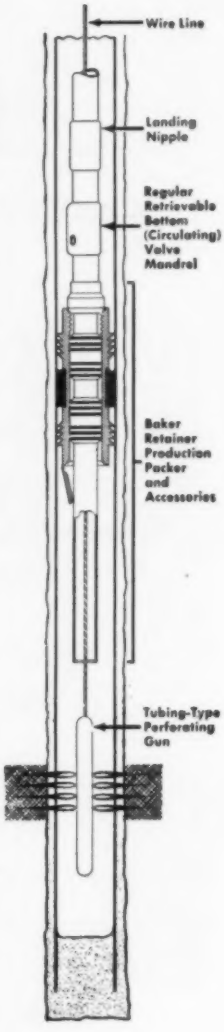
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

Use it as a squeeze and testing tool or as a temporary or permanent bridge plug in conjunction with any production application.


Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D" "E" or "F" Production Tube Product No. 457-D-E or F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.



Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

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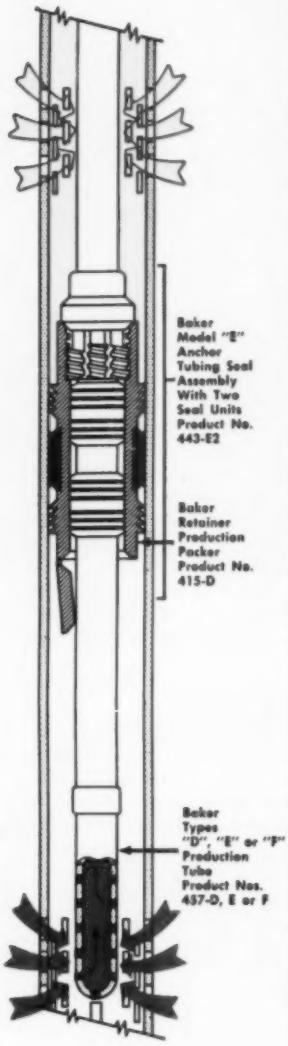
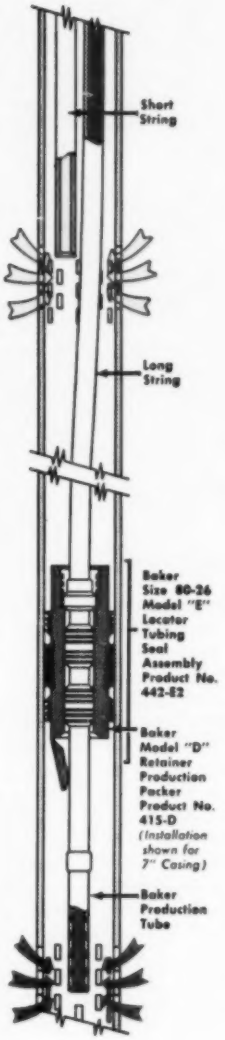
DUAL ZONE
Normal Completion


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

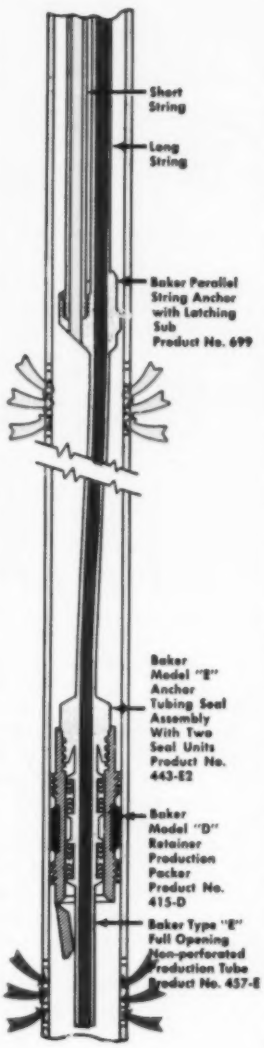
Illustrates Packer set in casing, with anchored production string for dual-zone production. Tubing can be released from Packer by rotating to right.

DUAL ZONE
Parallel String Short String Hanging Free


Short String
Long String
Baker Size 80-26 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

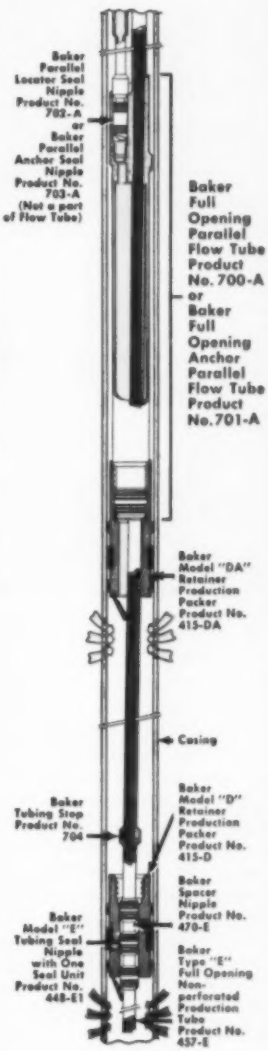
Permits removal of either string independently of the other regardless of sequence. Full-Opening (Tubing I.D.) Long String to lower zone.

DUAL ZONE
Parallel String Short String Anchored


Short String
Long String
Baker Parallel String Anchor with Latching Sub Product No. 699
Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Permits removal of either string independently of the other, however long string must be run first. Short string pulled first. Full-Opening (Tubing I.D.) Long String.

DUAL ZONE
Parallel String Two-Packer Hook-up


Baker Parallel Locator Seal Nipple Product No. 703-A or Baker Parallel Anchor Seal Nipple Product No. 703-A (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700-A or Baker Full Opening Anchor Parallel Flow Tube Product No. 701-A
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Casing
Baker Tubing Stop Product No. 704
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Spacer Nipple Product No. 470-E
Baker Model "E" Tubing Seal Nipple with One Seal Unit Product No. 448-E1
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Illustrates Two-Packer parallel string installation with each zone confined to its individual tubing string with full-opening to lower zone for use of all permanent-type completion tools.

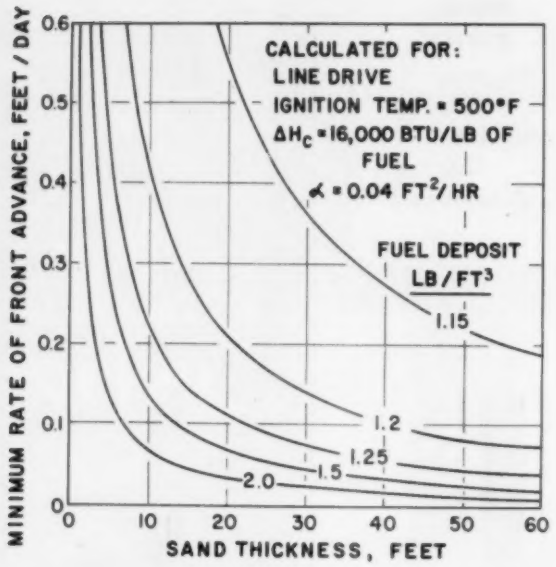


FIG. 5. **Minimum burning rate** in an ideal system, based on theoretical heat transfer calculations. Note that minimum rate is not only a function of fuel deposit but also depends strongly on formation thickness.

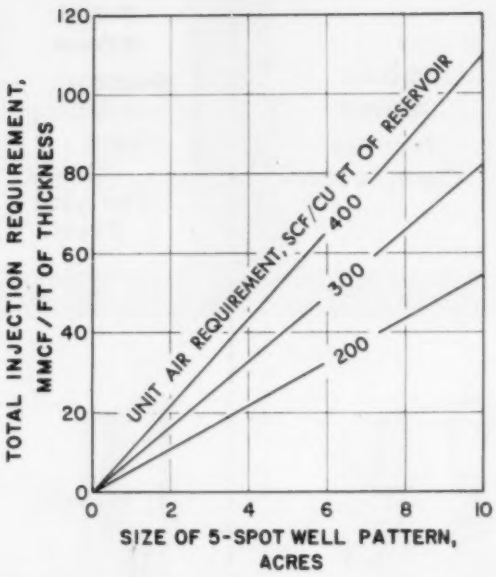


FIG. 6. **Total air required** per well at breakthrough in developed 5-spot pattern for maximum sweep of 62 percent.

amount of fuel deposited and, as a result, may be considered a dependent rather than a primary variable. The minimum RBFA also depends on a number of other factors; the extreme ranges that may be expected can be illustrated in a qualitative way by reference to an ideal system.

Consider a plane front burning a hypothetical fuel (with ignition temperature of 500 F and heat of combustion equal to 16,000 Btu per lb) and moving linearly in a homogeneous reservoir of limited thickness but of large areal extent. Neglect the heat-carrying effects of fluids and assume that heat is lost by conduction above, below and ahead of the front. Now define the minimum RBFA as that rate necessary to keep the temperature at all points along the plane of combustion above the ignition temperature of the fuel. Fig. 5 shows results of theoretical heat transfer calculations based on this simplified model. Note that the minimum RBFA is not only a function of fuel deposit but also depends strongly on formation thickness. Changes in properties of the fuel deposit also appear to have very great effects on the minimum RBFA. For example, with 1.5 lb per cu ft of the fuel selected, the minimum RBFA in a sand 10 ft in thickness was calculated to be 0.14 ft per day. With a more active fuel (ignition temperature of 300 F and heat of combustion equal to 20,000 Btu per lb) calculations of the same type show a minimum RBFA only about one-sixth of this value.

It is re-emphasized that the examples cited above are illustrative only. The absolute values of RBFA do not conform to field experience and should not be used as design figures. More detailed information on the mechanism and rate of combustion in porous rock will be needed to delineate this variable properly.

DESIGN FACTORS FOR IN-SITU COMBUSTION

With adequate knowledge of the operating variables peculiar to the in-situ combustion process, it is possible to investigate the basic design considerations which will eventually establish economics for a specific field operation. All of these factors depend on operating variable discussed above. Those factors concerned with rate are also affected by variables having to do with the multiphase flow conditions downstream from the combustion front; these are not sufficiently understood at present to include in this discussion. However, the work of Wilson, et al[15] has led to an interesting, though necessarily simplified, attack on this highly complex problem.

Total Air Required

The sand swept for any front location can readily be obtained by planimetering the swept area enclosed by the burning front (shown in Fig. 4) and converting to field units of measure. Multiplying this area by net sand thickness and the unit air requirement (standard cubic feet of air per cubic feet of formation), gives an estimate of the total air which must be injected to advance the front to a given location. Fig. 6 shows the *total* quantity of air required for breakthrough in developed, five-spot combustion operations as a function of pattern size for different unit air requirements. This is exactly the amount of air required to burn the total sand thickness to breakthrough. For the real case, where limited vertical sweep is obtained, less air will be required at the time of breakthrough of the front to producing wells because of the preferential flow through the burned zone. The air requirements thus obtained represent a safe upper limit; a better answer must await new information on vertical sweep.

Air Injection Rate

In order to size the compressor installation for movement of an underground combustion front in a given reservoir, air injection rate must be known. Methods do not exist at present to fix an *optimum* injection rate, even for a specific operation. However, if a reasonable schedule for rate of burning front advance (RBFA) can be set up, the air injection rate can be calculated from potentiometric model data of the type shown in Fig. 4. This is possible because the air flux (expressed as SCFH per square foot of frontal area) is proportional to rate of burning front advance,[11] the proportionality constant depending on combustion efficiency and fuel consumption.

What constitutes a "reasonable" schedule for the RBFA is a subject of some conjecture. A lower limit has already been discussed. An upper limit on RBFA probably exists for any specific field case depending on permis-

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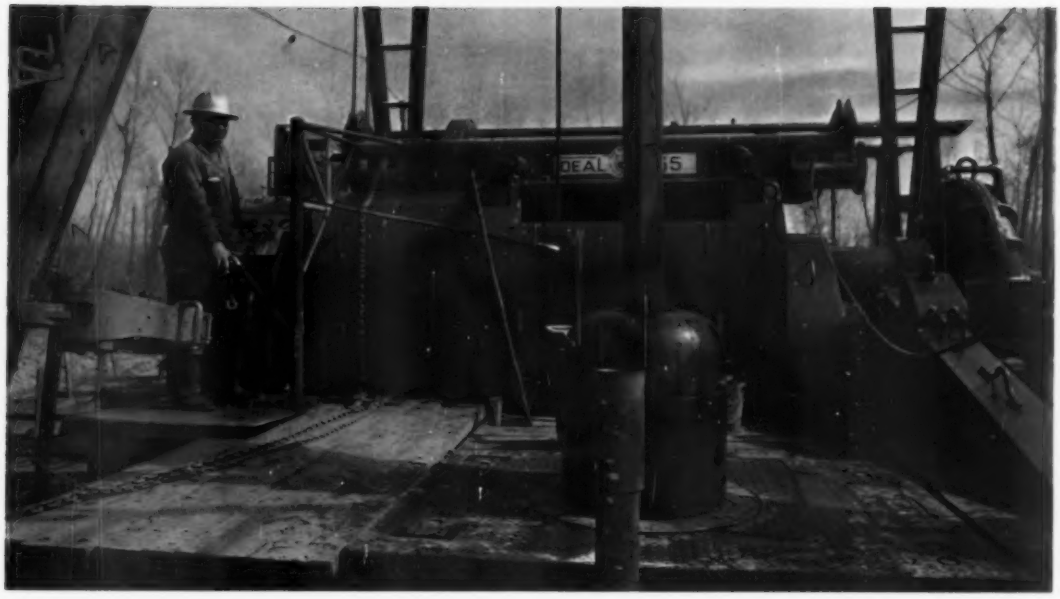

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A National Type SA-175 Rotary ready for delivery with other derrick equipment from National's Torrance, California plant. The Type SA-175 has a 17½" table opening with 44" spacing. Other models are the LA-175—17½" opening with 53¼" spacing—and the A-205—20½" opening with 53¼" spacing.

Direct table locks—Locking pawls, to prevent table rotation either direction as desired, are applied to recesses or notches on the table perimeter. This totally eliminates excessive strain and shock loading on the pinion shaft, and the need for a lock ring on the shaft.

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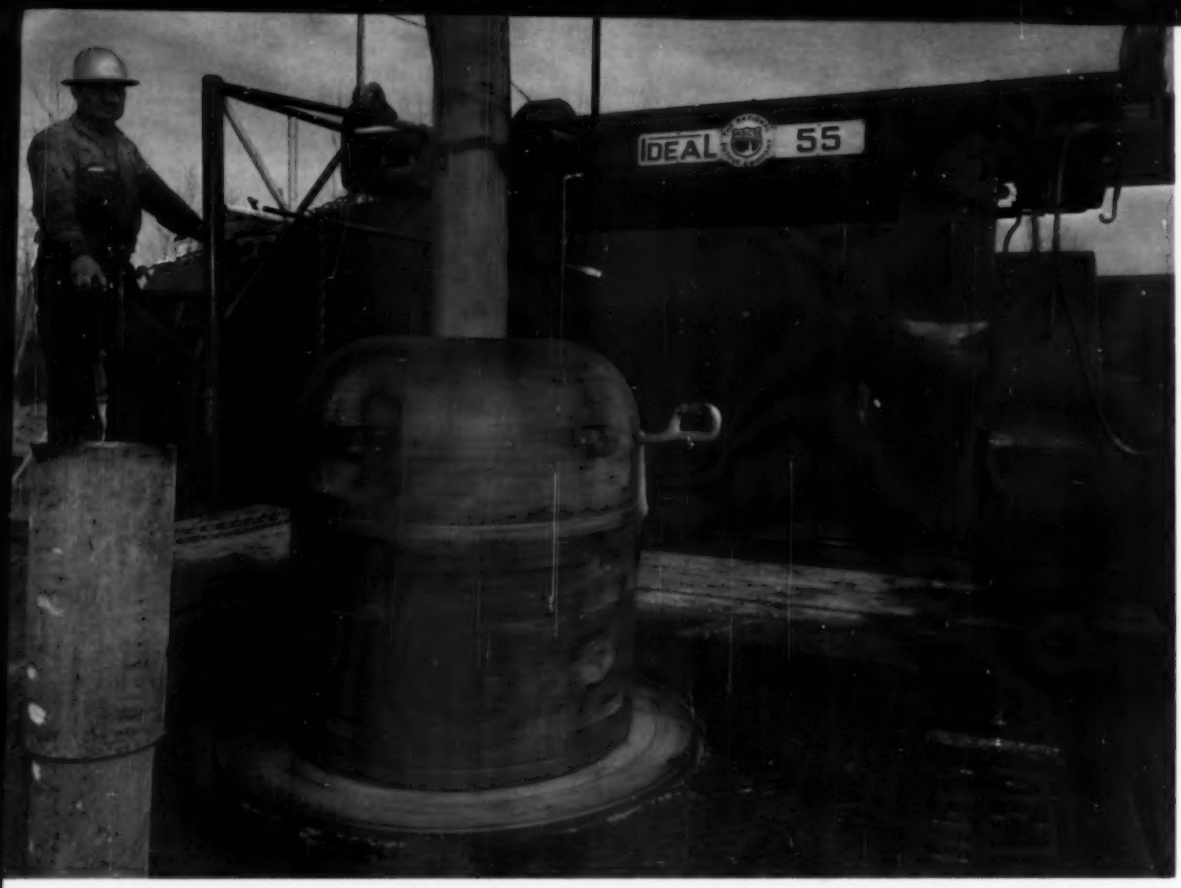
In addition to these special features, National Type A Rotaries have the construction benefits long associated with all National Rotaries—perfectly matched spiral bevel gears, proven main bearings, improved pinion shaft assemblies and wide, non-skid tread tops. Add all the features and you have all the good reasons why you buy wisely when you choose a National Type A Rotary. New models are available in the popular 17½" and 20½" sizes. See them soon.

National Rigs and their ratings on the next page!



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Type	Input Horsepower Rating	Depth Rating
8	120	1,000 to 2,000
12	200	1,500 to 3,000
20	300	2,000 to 4,000
32	400	3,000 to 5,500
45	550	4,500 to 7,500
55	700	6,000 to 9,000
80-B	1,000	8,000 to 12,000
110	1,375	11,000 to 16,000
130	1,625	13,000 to 20,000
1320	1,625	13,000 to 20,000
1625	2,500	16,000 to 25,000

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sible injection pressure (overburden pressure), well productivity, or an economic balance between capital investment (in the compressors) and rate of return as governed by oil production rate.

Oil Recovery and Production Rate

The maximum theoretical areal sweep of the burning front is expected to be 62 percent of the pattern area in a developed five-spot operation. Limited vertical sweep, as well as loss of oil consumed as fuel, further tend to reduce the percent oil recovered. Offsetting these effects to some extent, however, heat is transferred from the high temperature combustion zone to the neighboring unburned oil sand. Increasing the temperature of the oil sand makes the oil more mobile so that hot combustion gases leaving the burning front tend to sweep additional oil from the unburned portion of the pattern.

It is to be noted that 80 percent of the oil originally in place was reported to be recovered in the Worthington-Forest oil test.[14] While such a high recovery efficiency is not presently anticipated for all combustion operations, improved knowledge of the process may lead to higher areal and vertical sweep of the burning front. It is also quite probable that improved methods for transferring heat to, and displacing oil from, the unburned regions the reservoir will likely be developed as more field experience with this new process is gained.

Production rates associated with the combustion process are frequently several times higher than the normal primary production rate of field wells. This is especially true for heavy oils where the high viscosity of the produced oil greatly impedes primary production rates. After combustion is initiated, as the burning front reaches the vicinity of the producing wells, elevated temperatures ahead of the front reduce the viscosity of the oil. This results in increased oil production rates.

Example of displacement. The following example illustrates how oil is displaced by the burning front. Assuming steady-state conditions, the rate of oil displaced equals the production rate. Consider a burning front, 30-ft in vertical thickness, moving radially outward from an injection well at a velocity of 0.3 ft per day. For developed five-spot operations, the theoretical oil production rate is about 170 bbl per day when the burning front is located 100 ft from the injection well (assuming that the amount of recoverable oil in place is 1300 bbl per acre-ft).

Factors affecting rate. Theoretical oil producing rates then vary directly with: (1) Velocity of the burning front, (2) perimeter distance of the front, (3) thickness of burned sand, and (4) the recoverable oil content of the formation. Actual production rates could be expected to correspond closely to the theoretical rates but also would depend upon such factors as oil viscosity, sand thickness, effective permeability to oil, and other parameters that enter into conventional flow equations.

FIELD OPERATING PROBLEMS

Our field experience has shown that certain special problems of an operational nature are to be expected in combustion operations. Many of these problems exist primarily because of the relative newness of the process and will undoubtedly be solved as more field experience is gained. Some problems, such as possible high-temperature well damage, are peculiar to the thermal process and warrant special consideration.

High downhole temperatures. It has previously been mentioned that breakthrough of the burning front to a production well may not be necessary to achieve high oil recovery. This method of operation would circumvent excessively high downhole temperatures at the production wells. Still other methods of temperature control are readily suggested from the common principles of fire fighting: Remove one of the three ingredients necessary for combustion (fuel, air, or heat). For example, it may be possible to remove the supply of both fuel and air by shutting in a well. Unless heat is removed, however, putting the well back on production again would cause re-ignition.

To prevent re-ignition, the temperature around the well bore can be brought below the spontaneous ignition temperature of the crude oil by circulation of a heat-carrying fluid (oil, water, or gas). After the well is again on production, the circulation of the heat carrier can be maintained at a rate sufficient to keep wellbore temperatures in the desired range (below ignition temperature of produced oil and gas but hot enough to maintain high productivity).

Sand and corrosion. Other more common operating difficulties such as corrosion and sanding problems may be aggravated somewhat by high production rates associated with underground combustion. It now appears that problems of this type can be successfully overcome by the proper application of presently developed oilfield techniques.

RECENT IN-SITU COMBUSTION FIELD OPERATION

A list of 13 recent and proposed

TABLE 1. Some Recent Field Tests of In-Situ Combustion.

		Location			Reservoir Properties						Test Characteristics				
Date(1)	Operator	Field	County	State	Formation	Depth, ft	Thickness ft	Porosity %	Oil Saturation %	Oil Gravity °API	Well Pattern	Pattern Size, Acres	Ignition Method	Injected Gas	Reference
1952	Sinclair	Delaware-Childers	Nowata	Oklahoma	Bartlesville Sandstone	600	26	21	32	36	7-well (inverted)	5.2	downhole gas burner	air, product gas, natural gas	5
1952	Magnolia	West Loco	Jefferson	Oklahoma	Pontotoc Sand	180	20	29	60	18	3-well (in line)	(2)	electrical	air	7
1953	Magnolia	West Loco	Jefferson	Oklahoma	Pontotoc Sand	180	20	29	60	18	5-well (inverted)	0.07	electrical	air	6
1953	Worthington-Forest Oil	Parker	Clark	Illinois	Pennsylvania Sand	275	35	21	42	26	5-well (inverted)	0.28	injection gases heated at surface	steam, air, combustion gas	4,14
1954	Cal. Research, California Co.	Irvine-Furnace	Estill	Kentucky	Corniferous Limestone	70 to 1200*	0-61*	*	*	30-36*	*	*	*	*	12,18,19
1955(3)	Sinclair	Spraberry	*	Texas		8000*	10-165*	12-18*	*	32-42*	*	*	*	*	2
1956	Sinclair	Humboldt-Chanute	Allen	Kansas	Bartlesville Sandstone	600	23*	29	*	25	3:1 line drive	(4)	*	*	16
1956	General Petroleum(5)	South Belridge	Kern	California	Tulare Sand	700	*	*	*	13	5-well (inverted)	2.5	*	air	17,20,21
1956	Cal. Research	Midway-Sunset	Kern	California	*	2000	*	*	*	20	4-well (inverted)	1.2	downhole gas burner	air	19,21
1956	Richfield	Sisar-Silverthread	Ventura	California	Miocene Sandstone	1000*	*	*	*	11-30*	*	*	*	gas and air	22,23
1957(6)	Independent (Houston)	Camp Hill	Anderson	Texas	Carrizo Sand	500*	50-100*	35*	*	20*	*	*	*	heated air	24
Proposed	Sohio	—	Uinta	Utah	Asphalt Ridge	*	*	*	*	*	*	*	*	*	26
Proposed	Creole	*	*	(Venezuela)	*	*	*	*	*	*	*	*	*	*	25

*Specific data not released; values given are from published field data.
(1) Date of initiation of specific test, where available; otherwise, date of publication.
(2) 40 ft between injection well and most distant production well.
(3) Failed to initiate a moving combustion front.
(4) Two or more rows of input wells about 150 ft apart, spaced 400-500 ft from rows of production wells.
(5) Participating companies: Continental, Esso Research and Engineering, Gulf, Honolulu, Ohio, Shell Development, Sunray-Mid Continent, Texas, Tidewater, Union, Chanslor-Western.
(6) Whether ignition of oil sand is planned in this test has not been announced.

combustion recovery projects mentioned in publications and news releases at the time of this writing is presented chronologically in Table 1. As mentioned earlier, the first of these field tests were conducted in 1952, one by Sinclair,[5] and one by Magnolia.[7] The 1952 Magnolia field experiment was preceded by preliminary laboratory and field work starting in 1947; Sinclair initiated their field work in 1948. The second test, the Oklahoma five-spot experiment,[6] was initiated in 1953. In the same year, Worthington and Forest Oil started a test in the Parker Pool in Clark County, Illinois.[4, 14] Standard Oil of California conducted their early work in the Irvine-Furnace field of Kentucky[18, 19] in 1954.

Early tests encouraging. Results of these preliminary tests were, for the most part, highly encouraging; based on the information gained about the process, other large scale field tests were designed. Sinclair is currently operating in the northern part of the Humboldt-Chanute field of Kansas,[16] and California Research Corporation has completed an extensive test in the Midway-Sunset field, California.[19, 21]

Results and operating experience gained from Magnolia's three-spot and five-spot experiments were utilized in the design of the South Belridge test[17, 20, 21] operated by General Petroleum. This test, recently concluded, was conducted in the rich but low productivity 700-ft deep Tulare sand in Kern County, California. The widespread interest in the combustion process was evidenced by the number of companies participating in the South Belridge Test (see footnote 5, Table 1). When data from this test have been interpreted, economics of application of the process to heavy oil sands in California should be more firmly established.

Process not limited areawise. Geographically, in-situ combustion has not been limited to any one section of the country as shown in the map on the first page of this article. At the present time, three, and possibly four, thermal recovery projects are operating or have been completed in California. Some of these are not listed in Table 1 because they have not to our knowledge been publicly announced. Interest in California centers mainly around the numerous heavy oil deposits found in that state. In the mid-continent and eastern areas, three tests have been located in Oklahoma; one in Illinois; one in New York; possibly two in shallow oil deposits along the Missouri-Kansas border; one test in Kansas; and one in Kentucky. In Texas, Sinclair made a preliminary test in the Spraberry field,[2] and, currently independent Houston operators are making tests of an exploratory nature in the shallow oil sands of Anderson County in East Texas.[24]

A combustion project will probably soon be started in the Rocky Mountain region in Wyoming, and Sohio[26] has proposed a test in the Asphalt Ridge section of Utah. In Canada, thermal recovery techniques have been considered for several years as a possible means of producing the Athabaska tar sands. It is understood that some preliminary testing was carried out there during this last winter. Oil producers in South America are also apparently quite interested in applying thermal methods to some of their reservoirs. To date, tests have been considered in Venezuela by at least three different companies.

In summary, our present scoreboard on combustion field work reads: Seven test projects or field experiments terminated; nine projects underway, and four or more projects in various stages of planning.

IN-SITU COMBUSTION IN THE NEXT 25 YEARS

Developments in thermal recovery have come so rapidly during recent years that predictions concerning the distant future seem fraught with uncertainty. However, having seen the in-situ combustion process advance from infancy to the current state of knowledge in only one decade, we freely predict that the elapse of two or three times this period will surely be sufficient to fix its position and usefulness among available secondary recovery methods. The ultimate measure will be economics: Weighing the cost against the value of oil made available as compared with the other applicable techniques.

This necessary economic comparison requires more knowledge than is now available on the performance of waterflooding, miscible-phase displacement, in-situ combustion, and possibly other processes of potential merit. Areas of economic application of the various secondary recovery methods will be found to overlap considerably for the intermediate-gravity crude oils. However, as time passes the increasing value of the oil left in the ground should tip the scale toward those recovery processes which are most efficient in terms of ultimate oil recovery. The in-situ combustion process, properly engineered in those fields to which it is applicable, is perhaps the most effective mechanism now available for the separation of oil from reservoir rock. While oil recovery from the swept region, as observed in laboratory tests, is less than the 100 percent often quoted for miscible flooding (because of the combustion of a part of the heavier oil fractions as fuel) additional oil is obtained in combustion from unswept regions by-passed because of fingering of the combustion front. This "thermal drive" mechanism has no counterpart in non-thermal displacement methods.

Concerning the applicability of subsurface combustion specifically to Texas oil fields, a number of shallow, non-productive reservoirs producing low and intermediate-gravity crudes are known to exist in this state. An example which has resisted exploitation by conventional means and which is now under serious study by Texas Petroleum Research Committee and independent operators[24] is the extensive Carrizo-Wilcox sand in Anderson County.

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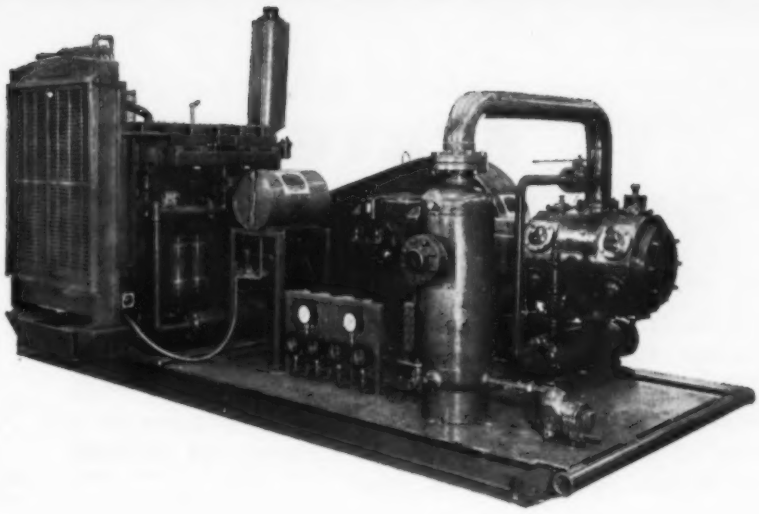

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STATE OF THE DRILLING CONTRACTOR

Four industry leaders representing (1) the drilling contractor, (2) a major operator, (3) a manufacturer-supplier, and (4) the independent producer give their views of conditions besetting the drilling industry at a meeting of the Dallas-Fort Worth Chapter of AAODC held in Dallas, Texas, May 26, 1958

. . . His Plight

. . . His Problems

. . . His Future

Do We Produce Oil as Cheaply as We Know How?

E. B. Miller, Jr.
Vice President and General Manager, Southern Division, Tidewater Oil Company, Houston, Texas

Some of the things going on in the petroleum industry today seem to make very little sense to many of us. I could discuss many facets of the Federal Power Commission's efforts to maintain the utility status of the thousands of independent producers of gas. This would not accomplish much, since I am sure we all agree that it is unfair, unworkable, and almost just plain ridiculous! We could discuss imports, but this wouldn't do any good either, since it would probably boil down to "rehashing" the same arguments — pro and con — which have been stated so voluminously for the past year.

I do want to discuss a problem I consider of prime importance to every segment of the industry. It may well be the determining factor in our ability to maintain a "strong, healthy, domestic industry," which everyone agrees is essential to the welfare and security of our nation. The problem is . . . "how to develop and produce our oil and gas reserves as economically as we know how."

One-third 1957 footage for exploration. In 1957, the total footage drilled in the U. S. was 219.4 million ft, which, at an average total cost of $14 per ft, amounted to $3.07 billion. Development footage amounted to 165.5 million ft, compared to 53.9 million ft for exploratory drilling, or a ratio of 3:1.

A good job is being done in lowering drilling costs, particularly when the difficulties associated with deeper drilling are taken into consideration. Combined efforts of manufacturers, drilling research to which the contractor contributes so much, and all the related industries are resulting in improved rate of penetration. **The important thing is that a free exchange of these developments exists, and is applied by the industry soon after they are demonstrated to be effective.**

Back to the problem . . . "how to develop and produce our oil and gas reserves as economically as we know how," the improvements in drilling technique are helping materially to accomplish this objective. If the industry is to maintain a strong economic position, **it is essential that the $3.07 billion spent annually must be spent in such a way as to contribute to the economic health, rather than becoming a parasite which sucks away on the remaining strength that is left.** An economic parasite works only on profit, which is the life blood of all industry. A sound economic producing segment of the oil industry is essential to the economic well-being of drilling contractors.

World competition must be recognized. Failure to recognize, at least to some degree, that our domestic production is in competition with the world supply of oil, is not realistic. Failure to recognize that cost goes hand-in-hand with competition is not realistic. In order to improve our competitive position, it is the duty and responsibility of every operator, large or small, every regulatory body, and every royalty owner to see to it that the industry produces oil as economically as it knows how, without creating physical waste.

Economic Waste

When I look at the record I cannot convince myself that we are doing this. When I see 26 wells drilled on 13 acres (and this has happened in recent years), I must conclude that economic waste

Oil Industry Issues was the key topic of the May 26 meeting of the Dallas-Fort Worth Chapter of AAODC. The panel consisted of, left to right: J. U. Teague, president, AAODC; Eugene M. Locke, president TIPRO; J. C. Magner, Chapter chairman; C. L. Vickers, treasurer and credit manager, Continental-Emsco Company; E. B. Miller, Jr., vice president, Tidewater Oil Company, and Brad Mills, AAODC executive vice president.

E. B. Miller, Jr.

A sound producing segment . . . is essential to the economic well-being of the drilling contractor.

has taken place, not for the individual, perhaps, but certainly for the industry. When I see an application for a permit to drill an 11,000-ft gas well on 5 acres, economic waste is going to take place. When it is necessary to install separate facilities for measuring oil and gas on each individual property, when proved equipment for a centralized system could have been installed for half the cost, we are not doing as well as we know how.

Every single one of these expenditures which does not add to the recovery from the reservoir, increases the cost of a barrel of oil, which makes it less profitable to the producer. If this unnecessary cost is added to the price, oil becomes less attractive in the world market.

Economic waste: 26 wells on 13 acres; an 11,000-ft gas well on 5 acres.

Technicians hamstrung. As individuals and as employees we spend large amounts of money educating and training young men and women for a place in our industry. The education and training they receive are good, they are well grounded in the technical principles of production, they are well grounded in economics, but, **in the scheme of operation as it exists today, are they hamstrung by antiquated practices and concepts of proration, well spacing, responsibility to private ownership, and the opportunity to produce oil as cheaply as they can for a competitive market?** I think so!

It was hard at first to understand how it was possible to train engineers and production men, gather together vast amounts of material, ship them halfway around the world, pay 50 percent of the profits as royalty on every barrel of oil produced, and haul it back halfway around the world and lay it down at our ports substantially cheaper than domestic oil. The answer is simple — more barrels of oil per well and lower unit costs.

Foreign operations a clue. If this is the answer for foreign operations, doesn't it follow that the domestic industry should take another look at its own operations to see if all possible is being done to get the same benefits?

Mother Nature might have been more lavish to the Middle East in the amount of oil deposited there, but she did not alter the basic laws of physics by which she allows it to be produced. Those laws are the same the world over, and are well understood by our technicians. Every day we read where some well in some far-off country was brought in producing at a rate of six or seven thousand barrels per day. So what? If you will look in your East Texas Proration Schedule, you will find wells which were actually potentialed at over 24,000 bbl per day. The Yates field has wells which will compete admirably with any on the face of the earth.

Efficient drainage important. It is not the individual well capacity which counts; the rate at which the reservoir can produce without waste is the critical consideration. Whenever we drill more wells than are necessary to efficiently drain a reservoir, we have added unnecessarily to the cost of development and production. Let me suggest, also, if it is determined that a reservoir is not being efficiently drained by wells on wide spacing, and there are accepted ways of determining this, more wells can always be drilled. But, did you ever try economically to undrill a well?

Wider spacing. I do not believe the end result of drilling on wide spacing patterns necessarily means fewer wells will be drilled. If a more realistic return on investment could be realized through higher per-well production rates, this profit would unquestionably flow into additional exploratory effort, resulting in new discoveries which would require development. Exploration effort is an expense, and, from some place within the earning structure of an individual operator or of a company enough profit must be generated to support this activity. Unnecessarily increasing the cost of developing established reserves does not accomplish this. We read a great deal about the risk involved in finding new reserves, and the importance of discovering new reserves to maintain our country's self-sufficiency. **If we can't make any money on our proved reserves, it is hard to see where the money is coming from to find additional reserves.**

Offshore operations. Our company, along with many others, has large amounts of capital invested in offshore operations. This area is conceded to be one of the most, if not the most, prolific new province for oil and gas exploration left on the North American Continent. To date the success ratio for discoveries of both oil and gas has been excellent. Large reserves of both have been found and many, many more remain to be found. Yet, if you have listened to oil executives talk, or, if you have read the statistics on activities offshore, it is apparent that there is growing concern about developing these vast resources. **What is wrong with a system which makes it questionable for a company, accustomed to taking risks in exploring for oil, to hesitate to proceed to develop it after it has been found?** There is only one answer: The production allowed each well is not sufficiently large to yield an attractive return on the large investment necessary to drill the well itself, let alone provide enough profit to build pipelines to get ashore, or carry on additional exploratory work. I do not think offshore operators want to steal away the state's allowable; I do think that they expect, and are entitled to, some method of allocation that allows a well to produce at a profitable rate so long as it does not create waste.

The present method of increasing production is to drill more wells; this completely disregards the ability of the well to produce, or the reserves behind the well to sustain its production. **The same total amount of oil being produced offshore today could be efficiently produced from about half as many wells.** Wide spacing, higher well allowables, and an opportunity for the industry to produce oil as efficiently and economically as it knows how seem particularly appropriate in an area where there is no diversity in royalty ownership.

Unitization helps. Onshore, private ownership of the land poses a problem of protecting property rights which, in far too many cases, has been the primary cause for drilling wells which were not needed to efficiently produce a reservoir. Substantial progress has been made in many states to correct this economic waste through their compulsory unitization laws: Louisiana,

. . . drilling on wide spacing pattern does not necessarily mean fewer wells will be drilled.

Oklahoma, Alabama, Arkansas, Mississippi, and New Mexico. Other states have means to accomplish essentially the same results through their proration formulae.

The state of Louisiana, through its Department of Conservation, at the present time has a study in progress to arrive at new formulae for prorating oil which will minimize the necessity of drilling unnecessary wells. This, in my opinion, is one of the most important forward steps that any regulatory body has taken in many years. **The development and administration of fair, equitable, and realistic formulae may well spell the difference between a strong, healthy, domestic industry, or an industry striving for survival with little opportunity for expansion.** This study has received the support of many operators, and is deserving of the industry's best efforts and fullest cooperation.

Some Changes That Would Help

I don't think I would have fulfilled this assignment, or taken full advantage of my opportunity, if I did not suggest to you some specific areas in which I believe changes are required.

1. Equitable unitization laws are needed in all states which do not have them. Texas, in particular, needs one because of its prominent place in domestic production.
2. A change is needed in the concept that 20 or 40 acres for an oil well, and 80 to 160 acres for gas wells, constitutes wide spacing. Operators, royalty owners, and regulatory agencies should all recognize that the efficient and economical exploitation of a field is going to inure to the benefit of each.
3. Proration formulae which give disproportionate weight to the well factor do not contribute to the industry's efforts to maintain an orderly spacing program.
4. Proration formulae should recognize proved reserves and include them as a dominant factor in the equation. (The formula now under study by the state of Louisiana assigns 50 percent weight to reserves.)
5. Because of the unique conditions offshore (cost of development, single royalty ownership, transportation problems, etc.) and, because of its importance to our national security, special rules should be established. These rules need not cause a reduction in the onshore allowable, but should permit offshore's proportionate share of the total production to be produced from as few wells as can efficiently drain a field. Every economy possible, and every sound drilling, development, production, and transportation technique must be applied offshore if our nation and the public are to enjoy the benefits of these great reserves of oil and gas. The Federal Power Commission should take cognizance of this in considering its price-fixing for gas.
6. Regulations should not deny the operator the right to use to the fullest new developments in completion, measuring and operating techniques and equipment. I refer to multiple completions, metering oil and gas, automation of lease facilities, or any other method or device which adds to the economy of producing. The rules should encourage, rather than deny their application once they have been proved sound and equitable.

There is need of a fuller and better understanding of the basic factors which cause our cost of production to be so high when compared to competitive sources. There are many things the industry knows how to do much more efficiently than it is now doing, that the satisfaction of selfish interests places a burden upon the entire industry, which directly affects its prosperity. A healthy, prosperous, domestic industry is essential to our country's welfare and security. **If the current recession will cause all segments of our industry — driller, producer, regulator, and royalty owner, to take stock of our past practice to see where improvements can be made, and affirmatively step forward and make them effective, then it may be a blessing in disguise and a promise for a brighter tomorrow.**

What is Happening to the Drilling Contractor?

C. L. Vickers
Treasurer and Credit Manager, Continental-Emsco Company, Dallas, Texas

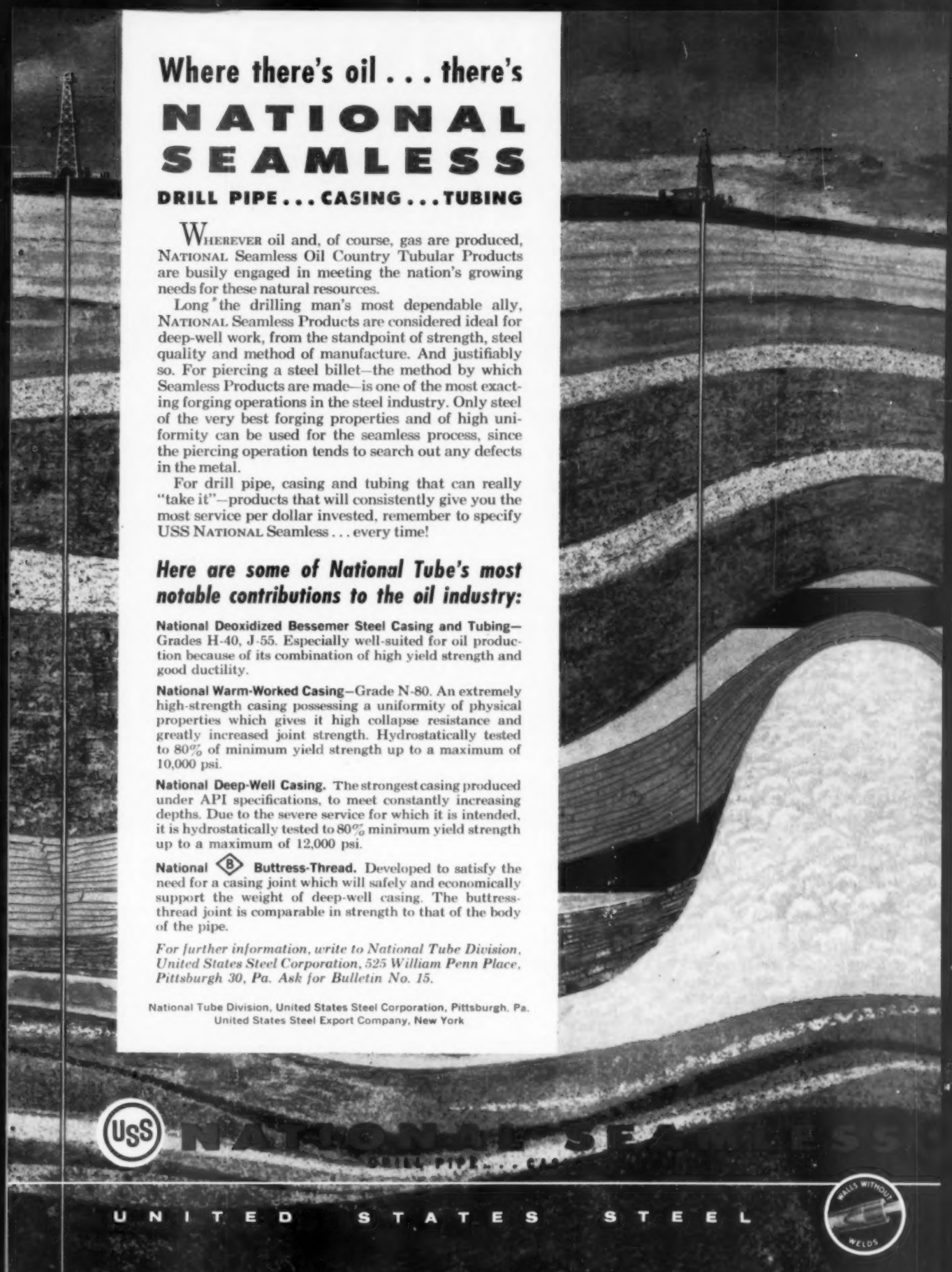
During 28 years in the financial end of the supply business, my closest association has been with the contractor and I certainly feel at home with him. This close association with the contractor has been due, in part, to the fact that contractors, in the purchase of equipment, have to look to the supply industry for financial assistance. Based on present conditions in the industry, I cannot see much change in this relationship.

I understand that some bankers in the past, in the course of their discussion, made it clear that banks would not lend their money using rigs for security. My experience in extending large sums of credit to contractors does not justify this position. The recession (and so far as the contractors are concerned, we would be justified in calling it a depression) has in no way dampened our faith in the contractor. **In my opinion, this feeling of confidence is in no way limited to my own company but applies to the entire industry.**

There are two groups of contractors who have abandoned your industry. Their reason for leaving is simply because they were losing their shirts. The first of this group is what we term the dealer contractor.

The Dealer Contractor

The dealer contractor is one who never bids on a contract or drills a well for any operator, but uses his rigs exclusively on wells on leases wherein he is the operator. These wells are paid for by co-owners or associates. We have always had this type of contractor, but I am particularly impressed that the number who fall in this category has been increasing very rapidly for the last 2½ years. This has been brought about by the fact that they realized quite some



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time ago that they could not remain in business under present conditions. Their operations have been limited to a certain extent by the disappearance of risk money; however, they have been helped, to some extent, by the fact that there are more favorable farm-out deals.

About 200 rigs are now being used on this class of work and these 200 rigs constitute a part of the rigs that are now active. The number of rigs falling into this class are increasing every day. These men are substantial people and are making some money. I do not feel that these rigs will ever be replaced.

There is another group of contractors that are no longer in competitive contract work. This group represents the more unfortunate class who have gone out of business because of financial conditions. For several months, a number of contractors have asked me how many rigs would be included in this group. I do not feel that the number will be more than 50 or 75 unless the conditions get much worse than they are at the present time.

. . . any newcomers to the drilling business will be people of very substantial means. . .

Disposition of Rigs

Rigs involved in this classification are, to a great extent, more than ten years old. They are in bad condition and could not be used in competitive drilling. I am inclined to believed that these rigs will be disposed of by the supply companies over a long period of time and will probably be used by the dealer contractor who makes the job fit the rig instead of making the rig fit the job.

New Rigs and New Contractors

We have a large surplus of rigs ranging in depth from 5500 to 8500 ft. I am inclined to believe that there will be very few rigs sold that fall into this classification. It is possible that there will be some demand for rigs to be used below 10,000 ft. When we talk of rigs to be used in depths below 12,000 ft, the amount involved may range from $600,000 to in excess of $1 million. This being the case, I think you can rest assured that **any newcomers to the drilling business will be people of very substantial means, and I am inclined to believe that there will be very few of them.**

It is my opinion that over the long pull, and by this I refer to the next five to ten years, that we will find a lesser number of small contractors, and the majority of the rigs will be operated by the larger contractors who are able to survive the present crisis. I think this is true from the standpoint of the cost of equipment, as well as from the standpoint of the necessity of having an organization that is technically trained.

Rig Sales — Last 9 Years

I have procured figures covering rigs sold from 1949 through 1957. I have not included in these figures a large number of small rigs capable of drilling down to 3000 ft. **During this nine-year period a total of 2410 rigs were sold by various manufacturers.** I find that 1566 of these rigs were sold from 1949 through 1953, and during the last four years of the period, only 844 rigs were sold.

Rigs sold in the first five years of the period grew out of Scurry County and Spraberry and, to a great extent, these rigs have been paid for. The rigs that were paid for during the first five-year period and the 844 rigs sold in the last four years have been used in an effort to pay for the rigs that were purchased in the latter period, and conditions have been very difficult during this period.

. . . in the immediate future, demand for rigs will not equal availability of equipment.

Rigs running. I think you will find there are at least 1000 rigs capable of running that were sold prior to 1949. This makes a total of about 3400 rigs available.

Rig investment. This gives you the facts that confront the drilling industry today. These rigs represent an original cost ranging from $600 million to $700 million, and it would cost nearly a billion dollars to replace them at this time.

Debt on rigs. Drilling contractors owe some debt on their rigs, but I do not feel that this debt would amount to more than 10 or 15 percent . . . so the contractor's equity in these rigs is quite large.

Future rig demand. I do not feel you can anticipate . . . at any time in the immediate future . . . that demand for rigs will equal the availability of equipment. This being the case, drilling contractors are faced with a serious problem.

Some Questions for Contractors Only

In connection with the serious problem facing the drilling contractor, here are a few questions I would like to ask them:

1. You represent the only industry in America that has gone through 15 years of inflation without a price increase. **Are you going to let your industry destroy itself?**
2. The job that you have done is due to the know-how you have developed. **If this know-how were forced into another industry, is it not true that the entire oil indusry will lose?**
3. You are tough traders when you buy a drilling rig. **What do you do with your trading ability when you make a contract?**
4. You are a tough financial man when you trade with supply house credit men. **Why do you pay thousands of dollars in interest because you are afraid to ask for your money when the job is completed?**
5. **If the operators knew this interest represented a part of the cost of their wells, don't you believe they would expedite the handling of invoices?**
6. **Why is it that other lines of industry can make some money and full depreciation operating at 50 percent of capacity, and in the case of the contractor, you go into the red when you drop below 75 percent.**
7. Your equity in drilling rigs is worth several hundred million dollars. **Are you going to wash it down the drain?**
8. **If you wear out the rigs you presently own, who is going to put up the money to replace them?**
9. **Is it not to the interest of the operator, the contractor and the supplier that you make sufficient money to replace your rigs?**

Some Realistic Assurances

I think we should give the drilling contractor a few assurances. First, **demand for rigs will not increase to the extent that you will recover your depreciation and make sufficient money for replacement!**

If the contractor continues on the present operating basis, he cannot stay in business.

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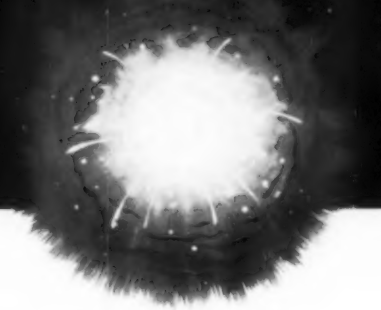

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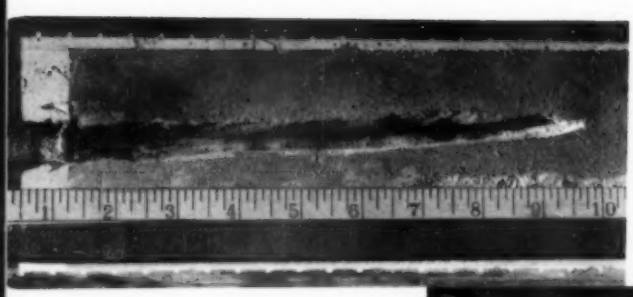

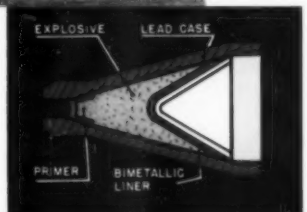

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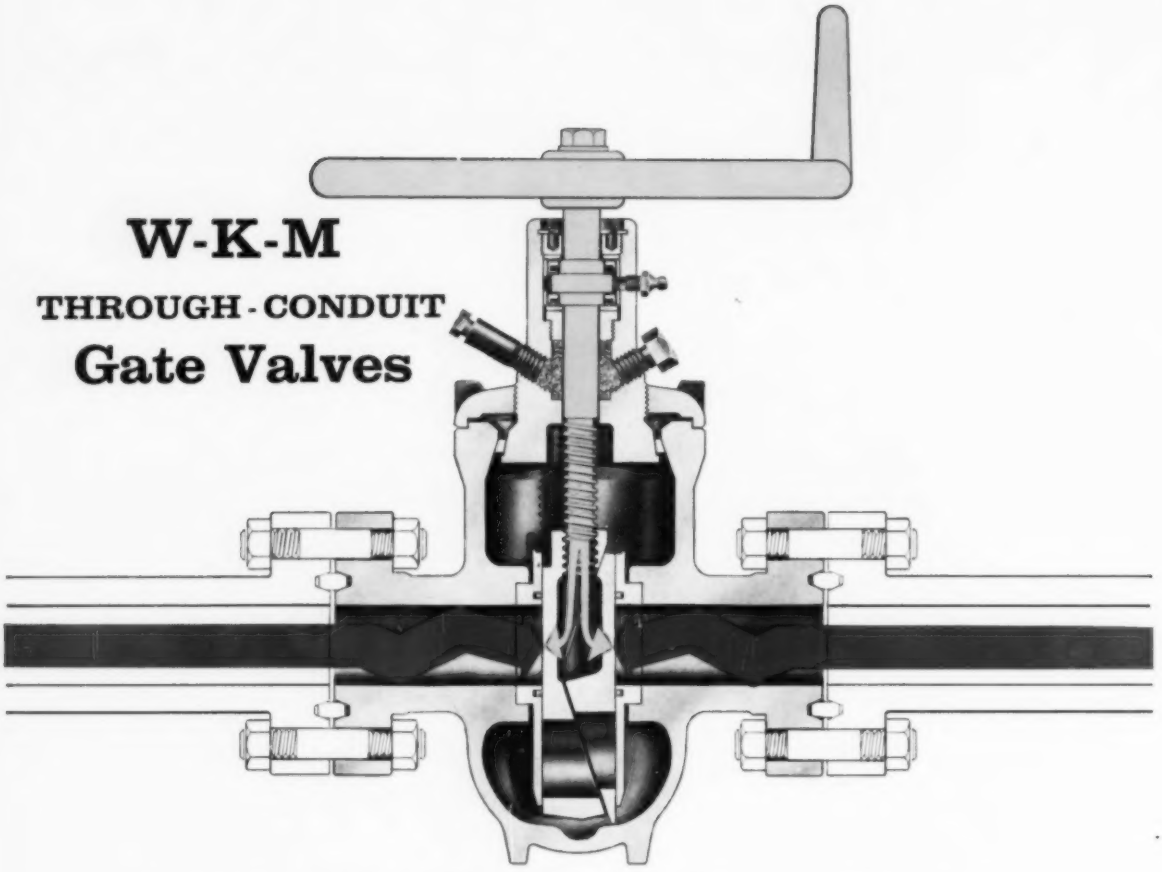

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1. **If you continue on your present operating basis, you cannot stay in business.**
2. **If you realize only depreciation out of the rigs, you cannot replace them out of the proceeds, and you will go out of business.**
3. **You will not lose the value in your rigs through obsolescence. You can make these rigs obsolete only by purchasing new rigs, and that will cost a lot of money.**
4. **Your banker doesn't want you to operate your rig at a loss. If he does, I recommend giving the rig to him. In the event you do this, I would like to know about it, because I would be interested in finding out what he does with the rig.**
5. **The supply industry is very deeply concerned because you are not realizing sufficient money to pay your debts and replace your equipment. We don't want the rigs that are under mortgage to us. We can live only when you live, and, beyond this, we would not have any place to put them.**
6. **You can recover from the present crisis only by each of you making a firm decision and a firm resolution that you will personally assume your responsibility to yourself, to your creditors and to the industry to conduct your business as businessmen in a free enterprise that operates for a fair profit.**

Status of the Drilling Industry

J. U. Teague
President, AAODC and
President, Columbia Drilling Company,
Houston, Texas

There is a statement in the Bible which, to my mind, aptly describes the contractor's position on this panel. Something is said, I believe, about Alpha and Omega—the beginning and the end. Certainly in Mr. Vickers, as credit manager of a great supply company, we have the "Alpha" of the contractor, and, unless we start getting more for our work, I'm afraid Mr. Miller, as the vice-president of a great domestic oil producing company, represents "Omega."

According to program theme, each of us was to talk about problems confronting the petroleum industry. That's a broad subject, which, to do it justice, would require a much longer time than I have alloted. I recall the invitation to this meeting promised the talks to be brief and interesting. I'll try to comply, at least as far as brevity is concerned.

The Contractor's Problem

The contractor's problem briefly stated is **"There is just not enough work."**

I really think one of the most trying things about the recession for the contractor is the reversal of our historic roles. In the past, when a contractor took a customer out to lunch, the contractor was expected to do a crying act about low prices, and unfair practices of his competitors. Now it is the customer who out-crys the contractor about 8-day production, imports, and management's demand for economy. It's hard to get accustomed to this new position, but I'm picking up some good pointers for future use.

The drilling contractor and his customers are in trouble, but so is all basic industry. Steel production is down to about 50 percent of capacity, automobile sales are off drastically, and railroads are saying they must have help to continue to exist. Our business is no worse off percentagewise than most others.

Drilling activity. We have been averaging around 1900 active rigs operating in the U. S. and Canada during the past few weeks. According to AAODC records, the highest monthly average in our history was 3188 active rigs in December 1955. **We, then, are operating at roughly 60 percent of our maximum effort.** In May 1947, we operated 1686 rigs, in May 1952, we operated 3007 rigs, the maximum effort of any May in our history. This would indicate that our business, like any other heavy industry, fluctuates with the economy as a whole.

The contract drilling industry, unfortunately, suffers more in depressed times than other segments of industry because of its highly competitive nature. **Our prices are the first to break and the last to move up.** Other segments of industry have been able to maintain their prices fairly well even in the face of reduced demand. This has certainly not been true of the contracting business. **The price situation has deteriorated to the point to where it is becoming intolerable.** The sad part of it is that the contractor has only himself to blame. He is paid what he charges. No customer can be expected to pay more than he has to for a service, nor will he.

Basis of trouble. Now, why are we in trouble? Well, as has always been the case, during boom times, our eyes get bigger than our stomachs. We bought too many rigs on credit because our customers drilled too many wells too quickly. We, along with all industry, expanded our capacity faster than our customers would absorb our out-put. We satisfied the pent-up wants and needs of the consuming public which had accumulated during the war years when consumer goods were denied them. The customer quit buying, and we quit working. When they start buying again, we will start working again.

In all of our attempts to legislate perpetual good times, we always seem to forget to repeal the law of supply and demand. As long as it remains on the economic statute books, I'm afraid we will be penalized when we violate it.

Future rig demand estimates. Estimates of the future demand for our services are difficult to appraise. A study conducted by the Chase Manhattan Bank of New York published in 1957, estimated we would have to drill **735,000 wells in the next 10 years,** if we maintain satisfactory domestic petroleum reserves. Certainly people who lend money to support the operations of this industry aren't given to rash speculation. Yet, **this year we may drill only 45,000 wells.** I recently talked to a friend whose company had employed a well-known economist to advise them, and he felt we could settle down to about 40,000 wells per year satisfactorily. Who is right?

Factors effecting future drilling. Certainly multiple completions, wider

spacing of wells, and the swing of interest toward gas production will have a depressing effect on the number of wells drilled.

On the other hand, all the so-called experts seem to agree that with a certain increase in our population, and our dedication to furnishing and ever-rising standard of living, we can reasonably expect a vigorous domestic oil industry for years to come. Estimates of future demands for petroleum are indeed staggering. It is estimated that **in 1966, a population of 197,000,000 people in the U. S. will require 14,000,000 bbl of oil per day.** Will these happy predictions come to pass? Only time will tell, but I think the odds are in favor of them.

Adjustments to be Made

But whether we drill 40, 50, or 60,000 wells per year, we will still need a lot of rigs to accomplish it. We contractors will have to adjust the number of our rigs to the demand, whatever it may be. When we accomplish this adjustment, prices will again adjust to a satisfactory level.

Suppliers can help. We ask the help of our suppliers in making this adjustment. We ask them to be hesitant in starting new, untried people in the contracting business. When business does pick up, we hope the supplier will not again flood the market with new rigs.

It seems to me better to have a few healthy cows to milk, rather than a whole pen full of sick ones.

We hope the supplier will avail himself of every opportunity to reduce the cost of distributing goods. A study of free delivery service costs could be a starter. A reduction in the number of sizes and types of drawworks and pumps you build, might be in order.

A new line of slush pumps were shown to me the other day. As I recall, there were nine different sizes. I can't conceive of a need for more than four. Certainly it costs money to maintain such a large range of merchandise. I think this money is needlessly spent.

Customers can help. We ask our customers to limit their bid invitations to established contractors who have good equipment, and are in a solvent condition. I think you will find many who meet these requirements — members of the AADOC.

A review of the requirements our customers make on contractors for special and unusual equipment might be in order. **Special blowout preventer hook-ups and slim hole drill pipe sizes often require maintenance of large investments in equipment seldom used.**

Helping themselves. We contractors must continue to work in every way to give our customers the most hole possible for his dollar. The AADOC's program is dedicated toward assisting its members toward this end by improving their technical efficiency, and upgrading themselves as businessmen. I think it is doing a fine job. **It is our hope that the day will soon come when supplier and operator alike will require the AADOC emblem on the letterhead of a contractor just as they do the API emblem on the equipment they buy.**

The Independent Oilman's Viewpoint

Eugene M. Locke
President, TIPRO, and Partner, Locke, Locke and Purnell, Dallas, Texas

You know better than I do we have problems in the oil business today greater than we've had since the great depression. **I think basically our three major problems are these: An oversupply of oil; Federal control of the price of natural gas at the wellhead, and public relations.**

You all know the public relations problem — the reason for it, though maybe not its solution. But I shall not try to give a solution in a few minutes tonight. Instead, I shall spend most of my time on the problem of oversupply of oil.

The Problem of Oversupply

In our opinion, **the primary cause of oversupply of oil in this country is excessive imports.** You know the imports problem as well as I do, so I won't talk about the existence of imports, or the effect of imports. I'll say instead a little about what we can do about it.

What to do about imports? There have been many suggestions made as to what to do about imports. The one best suggestion at this time is the proposed Ikard Amendment to the Reciprocal Trade Act. The Ikard Amendment was defeated 14 to 10 in the Ways and Means Committee in the House of Representatives in Washington, but that's just the first step. As they say, we've just begun to fight. What is the Ikard Amendment? It does these things:

1. It sets up mandatory controls.
2. It takes you back to the 1954 ratio of imports to domestic production.
3. It controls products.
4. It provides for a licensing arrangement whereby a producing company buys a license to take up its quota. The primary objective is to do away with the necessity of an individual in Washington determining quotas for various companies on what could be an arbitrary basis.

First, the question of mandatory control and the 1954 ratio. I think the basic objections to these that have been raised are:

1. That the voluntary system is working, and,
2. That you can't put the President in a strait jacket.

With regard to the last, the Ikard Amendment does not attempt to put the President in a strait jacket. The President in times of emergency or for very good reason can set aside for a temporary period the standard that is set up for import controls. Certainly, in the Suez situation, for example, he could do that.

Are Voluntary Controls Working?

We all know the difficulty that has been encountered in the past in getting various companies to go along with the voluntary program. At the present time, most of the companies are going along. But the basic fallacy is this: Even assuming they are all going along, how long will they go along? That means who is going to be the administrator of the program?

Captain Carson is a fine man; but whether the program works depends on that man. Second, it depends on the people behind that man. Does the administration really want the program to work? It could today; it couldn't tomorrow. Administrations change. Peo-

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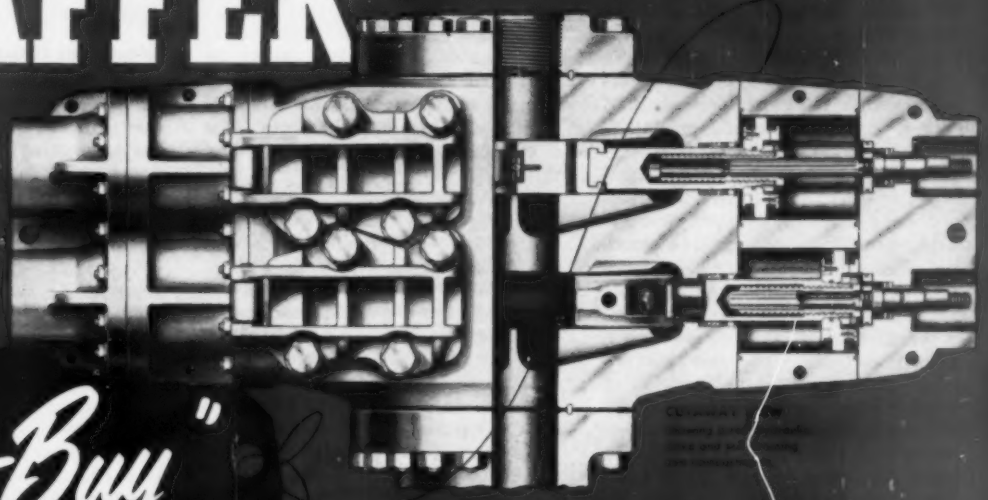

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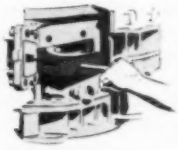

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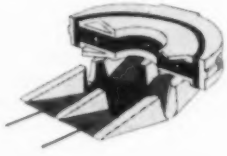

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ple change in those jobs. Third, will the companies have a desire to go along? Desires change and those desires are products to a certain extent, of the conflicting pressures on those companies. One of those pressures, of course, is that exerted by the stockholders.

An import standard. Any program, to really work, must have a standard. It doesn't help to say, "Sure the companies are all complying." The standard of compliance goes up this month and it goes up next month and it goes up the next month because of pressures.

What we are trying to do is keep imports down to the proper level, and not raise the standard. So the question of whether it's working is not just whether 97 percent of the companies are complying with some abstract figure. The figure itself is important. **It's a question of whether imports are being reduced to a proper level, or whether they are not being reduced.** Now, if you don't have a standard, what do you have?

Say an independent refining company says, "I need a quota. Why should Jersey have one, why should Gulf have one, and I not have one. I may not have imported much in the past, but I think I'm going to." **You can't have a quota system where only the major companies have quotas.** So you give that company a quota.

What does it come out of? Are you going to cut Gulf down? Gulf already has a quota. Maybe Tidewater already has a quota. They're going to resist that cut. So the Administrator has to either refuse a quota to the independent refiner or cut Gulf's quota or increase the total import level to take care of the new quotas. The natural thing to do, of course, is to increase the level, and say that the National Defense now requires this new higher level instead of the old level. Unless there is some kind of a standard, this will inevitably be the natural tendency of nearly any Administrator, I believe.

History of import controls. As to whether the voluntary system actually has worked, go back to the history of import controls. The National Petroleum Council in 1949 said that imports must be controlled in the interest of National Security. The National Petroleum Council is the council which includes the major oil companies as well as independents.

In 1953, the National Petroleum Council reaffirmed its stand and said that imports must be controlled. In 1955, we had the Security Amendment, the so-called Section 7, which is the basis of all the powers that Captain Carson has today. But as a prelude to the Security Amendment, both the Legislative and Executive branches of our government made substantial studies and these branches both came to the conclusion that imports must be controlled.

The Advisory Council to the President, commonly called the Cabinet Committee, which is made up of various cabinet members, made a study and came to the conclusion that the 1954 levels must be maintained, and, if the 1954 levels were not maintained, that the National Security would be endangered.

Quotes on import levels. The Cabinet Committee, in 1955, talking about 1954 levels, said, *"The Committee believes that if the imports of crude and residual oils should exceed significantly respective proportions that these imports of oil bore to the production of domestic crude oil in 1954, the domestic fuel situation would be so impaired as to endanger the orderly industrial growth to assure the military and civilian supplies and reserves that are necessary to the National Defense. There would be an inadequate incentive for exploration and the discovery of new sources of supply."*

Following the passage of the Security Amendment to the Reciprocal Trade Act in 1955, the Office of Defense Mobilization made attempts to get individual companies to comply voluntarily with the program, but imports continued to rise. On petition of the Independent Petroleum Association of America in 1957, another study was made, and the Office of Defense Mobilization told the President they thought imports were rising to a level which endangered the National Security. The President had the Cabinet Council make another study, and they came out with the same conclusion. As a result, a finding was made that the program should be implemented, and that Captain Carson should actually exert pressure on the importing companies to keep imports down.

Since that time Captain Carson has done a very good job in keeping imports down to some extent, but **imports are still very much higher than they were at the 1954 level, which was supposed to be the level that couldn't be exceeded without endangering the security of the country.** In Congress it was clearly specified in debate that the 1954 levels were really what they had in mind when they passed the Security Amendment.

Three major problems: Oversupply of oil; federal control of natural gas prices, and public relations.

What Has Happened to Imports?

The 1954 level is a percentage—16.6 percent — imports should bear to domestic production. If demand goes up and production goes up, imports go up, but in accordance with demand and domestic production, not to a greater extent than demand and domestic production. In 1955, imports were 118,000 bbl per day more than the 1954 ratio. In 1956, 249,000 bbl per day more. In 1957, 358,000 bbl per day more. In 1958, estimated 435,000 bbl per day more.

The war years. During the war, imports were 4.9 percent of the domestic production. In 1946, they grew to 7.9 percent. In 1954, the key year, they were 16.6 percent. The next year, 1955, they were 18.3 percent. In 1956, 20.1 percent. In 1957, 21.9 percent. In the first half of 1958, estimated for the year 23.3 percent. Unquestionably imports have risen dangerously and the only way, we believe, to correct this is to have mandatory controls and to have a definite 1954 standard written into the law which the President can, of course, set aside in times of National Emergency.

What about products? The Administration has said that products were not really a problem and products have not risen to such an extent that they needed controls. But obviously if you don't control products, control of crude oil imports will not be completely effective because the man that can't import his crude oil can always build a refinery in another country making products, and import these products. This has happened. Refineries are being built in various countries today for that purpose. Venezuela, for example, has been very anxious to have concessionaires refine a certain portion of their products in the country.

Product imports. In 1954, products imported averaged 42,000 bbl a day; in '57, 73,000 bbl a day; in '58, estimated 85,000 bbl a day. **Product importation today is about twice what it was in 1954.** But today it is nothing compared to what it will be tomorrow if products are not controlled. What does the President's Committee publicly say about products? Recently it said: "The Committee recognizes that it would be possible to circumvent this plan (the voluntary program) by companies entering into certain types of arrangements for the importation of the distilled products. So we feel products must be controlled."

Proposed Licensing Arrangement

Purpose of the licensing arrange-

It's a question of whether imports are being reduced to a proper level, or whether they are not being reduced.

ment is obvious. Companies bid, and the imports from various countries are allocated to the high bidder. The only problem that has been raised with the licensing program is the possibility that one company might take all the imports, which would not be proper. This is met by a provision in the Ikard Bill that the program must be administered to prevent monopoly and to give the small companies their share of the business.

Development down. What about cutting down imports in general? What are the two basic reasons for doing it? One of them, of course, is the security reason, and I've already read you what the President's Committee in 1954 said would be the result of not keeping imports at the 1954 level. They said it would endanger the National Security by cutting down drilling and exploration. And what happened? From 1955 to 1957, exploration crews at work were down 13.2 percent, rotary rigs active down 9.6 percent, development well completion down 5.2 percent, wildcat well completion down 4.3 percent.

After 1957 the figures are even worse. In 1958, we are running behind 1957 as far as exploratory work is concerned. As far as National Defense is concerned, it is absolutely necessary to keep these crews working.

Production and Reserves

It isn't the reserves that you use that are important. It's the relationship between the reserves that you use and the reserves you find. **If you don't drill wells, you don't find reserves.** There is an average number of reserves that has been found per well drilled. The fallacy of the argument that we are running out of oil is that we are running out of oil *only* if we don't find new oil.

Our reserves increases have been steady throughout the history of our country, until imports came in and drilling decreased. Drilling decreased last year for the first time in a long time. The reserves found were less, and for the first time we used more oil than we found. The reason was that we drilled less wells. And this was caused by imports.

Are We Running Out of Oil?

In 1891, the U. S. Geological Survey said, "Little or no chance for oil in Kansas or Texas." In 1914, the U. S. Bureau of Mines said, "Total future production only 5.7 billion bbl." In 1939, it was said, "U. S. oil supplies will last only 13 years." Of course, these prophecies seem ridiculous today. To keep our oil reserves, the thing to do is to keep the rigs going.

The Little Man in Big Business

There is one argument other than the National Security argument which is very important, and it hasn't been played up too much. **That argument is that we must keep the little man in business. Imports squeeze the independents;** they don't squeeze the major companies because most of the major companies are importing companies.

Mr. Miller hit the nail right on the head when he said that the problem was that we drilled so many wells here that we produce an average of say 14 bbl per well per day, whereas in the Middle East they produce many thousands of barrels per well per day. His recommendation was forced unitization. But the problem is that U. S. wells have already been drilled.

I do not believe in forced unitization; for this would require our people to sacrifice their basic property rights, which is certainly contrary to our principles of individual liberty. Many of you have known of situations where a man had certain acreage on the top of the structure, and the majors in the field, with 95 percent of the proposed unitized area wanted to force him to unitize on an acre-foot basis. This would cost him a great deal of money and property, and to force him to do so against his will, we think is bad.

Little man big in oil. Keeping the little man in business is far more important than it would seem at first blush. **The oil business today is virtually the only heavy industry business in the U. S. where the independents, the little men, play an important part. The independent finds over half of our oil.** Look at the steel business, look at the chemical business, look at the automobile business, look at the utility business. There the little man—the independent—does not play the important role he does in the oil business.

A chance to be a capitalist. It is important to keep the little man in business, because our entire system of free private enterprise depends on it. There are very few people who would be Socialists if they had a chance to be capitalists. To believe in free private enterprise, a man doesn't have to be a capitalist. He just needs to think he has a chance to be one. There are not too many people who think they can be president of the Standard Oil Company of New Jersey. If that's their aspiration, maybe they become Socialists because they can't achieve that. But there are multitudes of people who think they can go out and find a little oil for themselves as independents. And, they're the boys who will continue to be capitalists if you continue to give them the chance to find their oil.

The difference between this country with our free private enterprise and Europe is that Europe was run on the cartel system for many years. They don't have people over there who think they can go out and make a buck if they have a little luck, and a little brains, and will work hard enough. That's very important.

Price Regulation and Natural Gas

The other important problem is that of control of the wellhead price of natural gas. I won't say anything about the Harris-O'Harra Bill or its future. But, there is one argument I think is basic. Again, it is this free enterprise argument on gas that hasn't been mentioned too much. This is significant because it shows a bad trend in government thinking. Mr. Connole, who is on the Federal Power Commission, talked to our group in Galveston a year ago, and he said you have to regulate gas because it is in the public interest; that it has become so big and embued with the public interest that the price must be regulated.

Basis for price regulation. In the past, two things have been necessary for price regulation. One of them is public interest. The second is monopoly. If you have a monopoly granted to you by the government, the government ought to be able to regulate the price of your product. When you don't have a monopoly and when you say that the only thing is public interest, where does that leave you? What is more in the public interest than food, and the beef, wheat, and other staples in our diet? What is more in the public interest than housing, and the cement and brick and lumber and copper and steel that goes in a house? What's more in the public interest than clothing and the cotton and the wool that make up the clothing? And the sheep from which wool is sheared?

Any time you say that you can regulate the price of any commodity in peacetime if it is in the public interest, you can regulate the price of every commodity sold in the U.S. The people in the North and the East don't know that. That story hasn't been told to the people of the consuming states. Yet, it affects them. When you regulate the price of gas at the wellhead, you're not just talking about gas. You're talking about all commodities, including the ones they sell in the North and East. ★ ★ ★

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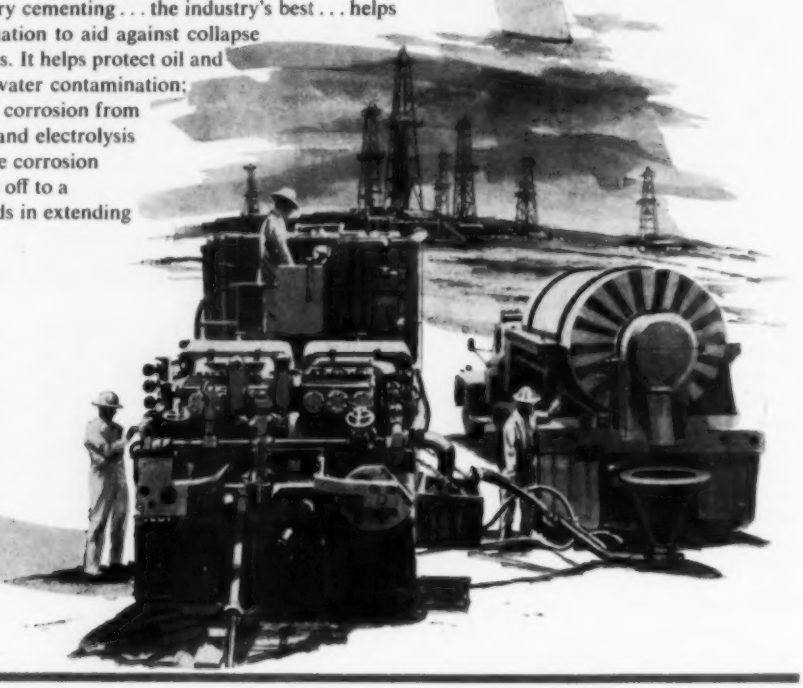

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Constructed of strong, drillable materials and filled with special-formula shock resistant concrete for extra strength and protection during the cementing job. Collars are available with or without fluid-flow opening through the concrete baffle. A Baffle Collar with opening is placed in the string of casing one or more joints from bottom to stop the Top Cementing Plug, allowing ample cement around the shoe . . . A Baffle Collar with solid baffle and cementing ports above is used with Cement Baskets installed below to catch cement pumped through the ports to the outside for protection of a lower porous formation.

TYPE "M" CASING SHOE

A short, open-end casing shoe that reinforces lower end of casing column to reduce damage to casing, aids in running-in past hole obstructions. Used in rotary drilled wells where it is not necessary to float the casing to bottom.

ADMIX SAFETY FLOATING EQUIPMENT

Provides protection when pumping granular or flake additives in the cement slurry. Minimizes the hazard of leaving the casing filled with additive-mixed cement should the Float Collar or Float Shoe become plugged. Safety plugs pump out at a pre-determined pressure, permitting placement of slurry through ports located in the upper body.

ADMIX SAFETY FLOAT SHOE

TYPE "K" COUPLING SHOE

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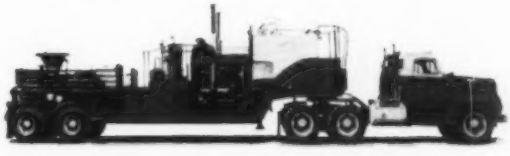

"THERE IS NO SUBSTITUTE FOR EXPERIENCE IN OIL WELL CEMENTING"

Part 2 (conclusion)

Sand Exclusion in Oil and Gas Wells

Comprehensive treatment of bridging and consolidation techniques and modern applications of each, including equipment and methods

G. H. Tausch and C. B. Corley, Jr.
Humble Oil & Refining Company
Houston, Texas

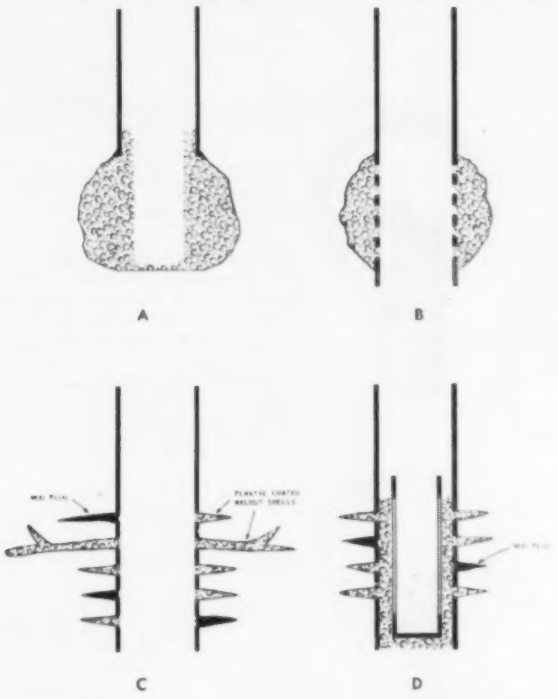

FIG. 11. Plastic coated walnut shells in sand control applications. (A) Open hole cored out. (B) Perforated casing with cavity filled with plastic coated walnut shells. (C) High-pressure placement behind perforated casing. (D) Aluminum screen and liner set in hardened plastic coated walnut shells.

PLASTIC-COATED WALNUT SHELLS

PLASTIC-COATED walnut shells are composed of ground and graded shells that are precoated at the surface with an extremely thin coat of unset plastic.[5] The size of the ground walnut shells is selected in the same manner as the size of gravel and the sizes normally available are 20-30, 20-40, and 30-40 mesh. The high permeability of the bonded shells when in place has allowed a much smaller particle size than is used with gravel, and 20-40 or 30-40 mesh is commonly used in field operations and is small enough to stop any formation sand. After the shells have been coated with plastic at the surface, they are circulated into position with carrier fluid or viscous low-gravity oil. The use of this oil prevents excessive settling and will not leach the catalyst or harm the plastic. The type of plastic and amount of catalyst are dependent upon well temperature and the length of time desired for placement. The plastic coating on the walnut shells will harden and bond the shells together, forming a highly permeable filter bed.

Two methods. The placement procedure may be divided into two techniques: 1. The use of penetrating fluid and low pressure to allow the shells to filter against the sand face as the carrying fluid enters the formation (Fig. 11A and B); and 2, the use of high pressure to fracture the formation and leave the shells in the fracture as a propping and filtering medium (Fig. 11C). When mud filter cake fills casing perforations or covers the sand face, high fracturing pressure must be used. The removal of excess shells from the casing or open hole may also be performed by two methods: 1. Drilling, and 2, reverse circulation.

At initial inspection, this would appear to be the almost perfect type of sand control, i.e., a very permeable filter pack which is bonded as a single unit for high strength and permanent life. Thus far, the success ratio has not been as high as anticipated. There has been no apparent difference in success ratio whether or not drilling mud contacted the sand face. This leads to the following speculation: 1. That the creation of a fracture that remains propped open is of major importance in this sand exclusion process; and 2, that the bonding action of the set plastic may be inadequate, particularly when the shells are deposited as a small volume or thin film. When mud-filled perforations are opened by fracturing, only a few holes will probably be opened. Therefore, success hinges upon obtaining sufficient flow through the fracture and open perforations to keep a low pressure differential on the mud plugs and prevent their removal. Production through the fracture may leave doubt as to effective reservoir drainage. By the same token, results have not been good when this process was used without fracturing on initial completions after perforating in clean fluid. Results may be improved without fracturing in a mud-free environment when sand production has occurred, permitting the placement of a large amount of shells. Because the plastic film on the shells is extremely thin, the shells must be held in intimate contact until the plastic sets.

In an effort to eliminate the problem of plugged perforations which may release and permit sand production, an aluminum screen and liner has been combined with plastic-coated walnut shells (Fig. 11D). This aluminum screen acts as a die to permit the formation of an annular ring of bonded shells within the casing which will prevent any mud plugs from moving. Production is still obtained

Part 1 published in June 1958 issue from a paper by the same title presented at the Spring Meeting of the Southern District, Division of Production, API, in Houston, Texas, February 26-28, 1958.

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is the real villain in sucker rod pump troubles. It accounts for most of your repair and pump pulling expense.

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for getting away from this trouble has always been to make use of the best available materials — *Natural Rubber* for the key material in plunger rings; *Synthetic Rubber* for the key material in resilient ball guides for cages.

The accurately grooved and drilled metal body of **The Martin Plunger** does not touch the barrel. Only the resilient rubber and duck rings contact the barrel. This material — with its great natural resistance to abrasion as well as its slipperyness-when-wet — has a much slower wearing action on the barrel. Most often your barrel will not need replacing. These rings have an amazing ability to take the kind of abuse that goes with oil well pumping, and this means longer runs. Plunger cost is reduced because replacing the rings costs only about one fourth as much as a new plunger, and this saving is, of course, added to the barrel saving and longer runs.

Patent No. 2,591,174

The Martin Rubber Guide Cage protects the ball from all metal contact except when it rests upon its seat. The ball is protected to such an extent that ball and seat life is usually doubled. The synthetic ball guide and stop cannot beat out because of its resilience. Its life is therefore much greater than any metal and you get this longer cage life in addition to better ball and seat life. The two guides are easily replaced when the occasion does arise.

No real capital outlay is required to get these benefits because the cost of Martin Plungers and Martin Cages is very much the same as you are now spending for replacements — sometimes less.

All regular or stroke-thru ROD PUMPS and TUBING PUMPS can be equipped with Martin Plungers. Martin Rubber Guide Cages are made in all sizes and styles. Write for our catalog No. 4; also see Composite catalog for 1956-57.

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Developed after years of testing and metallurgical research, a *new* Hughes heat treating process has more than doubled the tension-impact strength of "Flash-Weld" tool joint-to-pipe connections.

Special tension-impact test equipment had to be developed by Hughes engineers in order to be able to fully evaluate the metallurgical properties obtained in the weld area by the new process.

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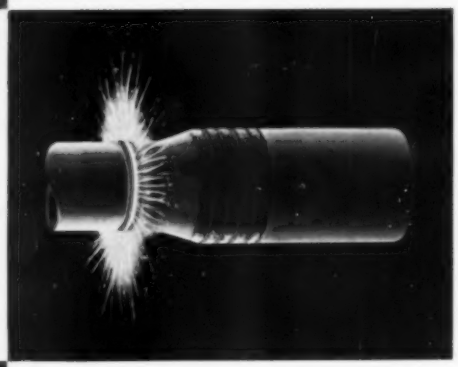

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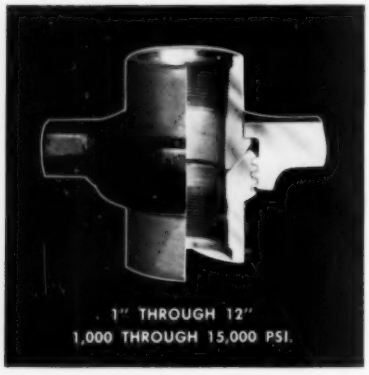

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from the fracture and open perforations. Once the plastic has set, the screen may erode or corrode with production and later may be removed by drilling. The success ratio has increased with this technique, but these jobs have produced a small amount of sand indicating that the shells are not packed tightly behind the screen or are not bonded together effectively.

At first look, this technique would seem perfect for use without a rig inasmuch as sand control may be accomplished without a screen and liner and the casing is left open for later wire-line remedial operations. Too few jobs have been performed to evaluate all facets of the wire-line technique. The success on initial completion has not been as anticipated. A better job can probably be obtained if sand production occurs before placement of the shells. The creation of a permeable bed of shells around the casing, however, may make later ratio-control by cementing virtually impossible unless intact shale stringers remain in contact with the casing.

With the wire-line method, excess shells must be reversed from the well and cannot be drilled. They must be reverse circulated through pipe extending below perforations and cannot be removed while slowly lowering the well tubing or drill pipe. Experienced engineers have been able to cope with the bridging of shells that occasionally occurs upon reverse circulation; however, this problem has not been evaluated.

CONSOLIDATING PLASTICS

Approximately 15 years ago, laboratory investigations into the field of sand exclusion produced a consolidating plastic.[9, 10] This sand-exclusion technique initially was designed for the impossible wells which could not be controlled by the then available sand-control techniques. Cost of the technique was slightly higher, but this additional cost would be more than offset if the technique were more successful. The use of consolidating plastic, however, was doomed to failure because of the then prevalent completion technique. All wells were initially perforated in drilling mud, and some mud-plugged perforations were always present to prevent the entry of consolidating plastic into the formation sand (Fig. 12). Pressure differentials into the well bore during production of the consolidated wells dislodged the mud plugs, again permitting sand production. Before this technique was temporarily abandoned, the success ratio was increased greatly by a procedure of squeeze-cementing wells, reperforating in salt water, and then performing the consolidation. Failure to drill-stem test the squeeze-cement job may have permitted later cement failures and recurrence of sand production that accounted for the failure to obtain a still higher success ratio with consolidating plastic.

Advent of the permanent completion technique that permits completion in a clean fluid and permits production and remedial operations without the use of plugging materials provided a perfect environment, and the accent on offshore operations provided an incentive for plastic consolidation. The quantity of offshore wells, also deeper producing wells, demanded a sand-control technique that allowed later remedial operations of squeeze-cementing and ratio control by the wire-line technique since elimination of a rig has proved highly profitable. Success to date with consolidating plastic in this new round of endeavor is indeed gratifying. All jobs have been performed by the wire-line technique (Fig. 13), and only the one well, which previously had been contacted with mud, has had sand production. Although a workover rig may satisfactorily be used with consolidating plastic if the proper environment is maintained, the wire-line technique has been utilized because of its safety and convenience on shallow inland wells and its additional economic advantage on all other wells.

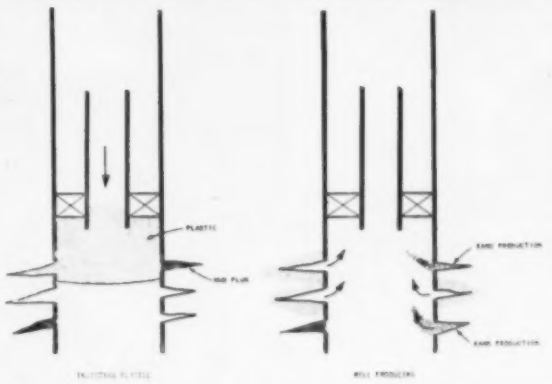

FIG. 12. Placing consolidating plastic by conventional method. Plastic is injected into perforations at left, and followed by a small overflush of oil. Condition of bottom of well under producing conditions, right.

Nature of plastics. Commercially available plastics used for sand consolidation to date[11] and the plastic now used but not available commercially[12] are of the phenolic type using either an acidic or basic catalyst to control the reaction time. The plastic is generally composed of two materials such as formaldehyde and phenol. Cresol is substituted partially or entirely for the phenol in the lower temperature range to control reaction time. The catalyst serves two functions: 1. It controls reaction time, and 2, it acts as a wetting agent to allow the sand grains to be plastic wet. The importance of this latter action cannot be overemphasized, inasmuch as it permits the plastic to replace the interstitial water and prevents the excessive permeability reduction that is generally associated with consolidating plastic. Effectiveness of the catalyst as a wetting agent can be exhibited by the tenacity with which the plastic adheres to glass beakers, virtually fusing with the glass and making their whole separation impossible.

Placement technique. The consolidating technique consists of displacing the well fluid with oil in an effort to eliminate water which is detrimental to the plastic. With a tubing extension in place below the perforations, a volume of oil, generally 15 to 20 bbl, is pumped into the formation to obtain the highest possible oil saturation around the casing perforations. Plastic is displaced around the end of the extension and across the entire perforated interval before closing the casing valve and forcing the plastic into the formation with bradenhead squeeze pressure. Surface pressures are frequently exhibited on the well after it has been circulated with oil, and the wire-line technique permits well control with surface pressures and permits plastic to be circulated across the perforations prior to squeezing. After the plastic has been squeezed into the formation, several barrels of oil are squeezed through the perforations from both the tubing and casing to assure that no plastic remains within the well bore. Thus far, indications are that two stages or injections of plastic are required per job. After the first stage of plastic is set, the well is allowed to stand idle and a second identical stage is then performed before placing the well on production. For each job, at least 20 gal of plastic are currently recommended per foot of perforated interval. With short perforated intervals, a minimum quantity of plastic must be used that will permit accurate volume control during placement.

Limitations. To date, consolidating plastic has certain

IN THE ROCKIES, many soluble pays respond best to a combination acidizing and fracturing service. Acid Petrofrac* employs an acid-oil emulsion that not only carries sand well but provides a retarded acid action during treatment. Many wells respond to this double action with fast payouts and slow decline curves.

IN OKLAHOMA, Sandfrac*, using refined oil or lease crude as the fracturing fluid, is particularly suited for many formations of low solubility. Refined oil of medium gravity has many of the desired qualities of a fracturing fluid. On occasion, lease crude is modified with F.L.A.* (Fluid Loss Additive) to lower its fluid loss.

ON THE GULF COAST, the tighter formations are often fractured with Stratafrac*. The fluid used in this service is an acid-kerosene emulsion that has excellent sand-carrying characteristics. It has proved to be reliable and is designed to clean up fast. Addition agents can be added to prevent silicate swelling and emulsions.

IN CANADA, Waterfrac is used to fracture various gas producing formations. The thickened water used in this service is designed to carry high concentrations of sand down tubing effectively. The materials used in Waterfrac may be prepared and hauled to the location, or mixed on the job. The resulting fluid is not volatile.

Why Dowell Offers The Widest Variety Of Fracturing Services In The Oil Industry

Oil and gas bearing formations exhibit infinite variations in composition, fluid content and type of drive. It's no wonder then, that a single fracturing fluid or technique can not be used to produce best results in all wells. That is why Dowell offers nine basic fracturing services — with many variations of each.

Take, for example, the question of formation solubility in an acid-base fracturing fluid. In the case of a highly soluble limestone it may be necessary to slow down the acid action. In the case of a dolomite, an intensified action may be desirable. To meet this wide variety of solubility problems Dowell has developed many addition agents to alter the action of its acid-base fracturing fluids.

Also, consider the question of fluid injection rates. While high-injection-rate fracturing has proved highly successful, it is not always economically sound to pull tubing for a frac job. And injection rates are limited when it is necessary to pump down the tubing. To meet these different requirements, Dowell offers many fracturing fluids with varying sand-carrying abilities. In high-injection-rate jobs fresh water or unthickened lease crude are low in cost and have sufficient sand-carrying capacity — but for injection down tubing, emulsified or jelled fluids and FLA* (Fluid Loss Additive) are often recommended to prevent sand screen-outs.

Solubility and injection rate are only two of the many variables your Dowell engineer considers before helping you choose the best fracturing service for your well. When his study of your problem is complete, he can select from the widest variety of fracturing services in the industry. He can fit Dowell's specialized pumping equipment — including the famous Allison aircraft engine pumper or the smaller twin diesel pumper — to the job requirements. For the more unusual problems, he can call for assistance from Dowell's vast research and laboratory facilities in Tulsa.

Take advantage of this knowledge and ability on your next fracturing job. Call any of the 165 Dowell service points. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Dowell, Tulsa 1, Oklahoma.

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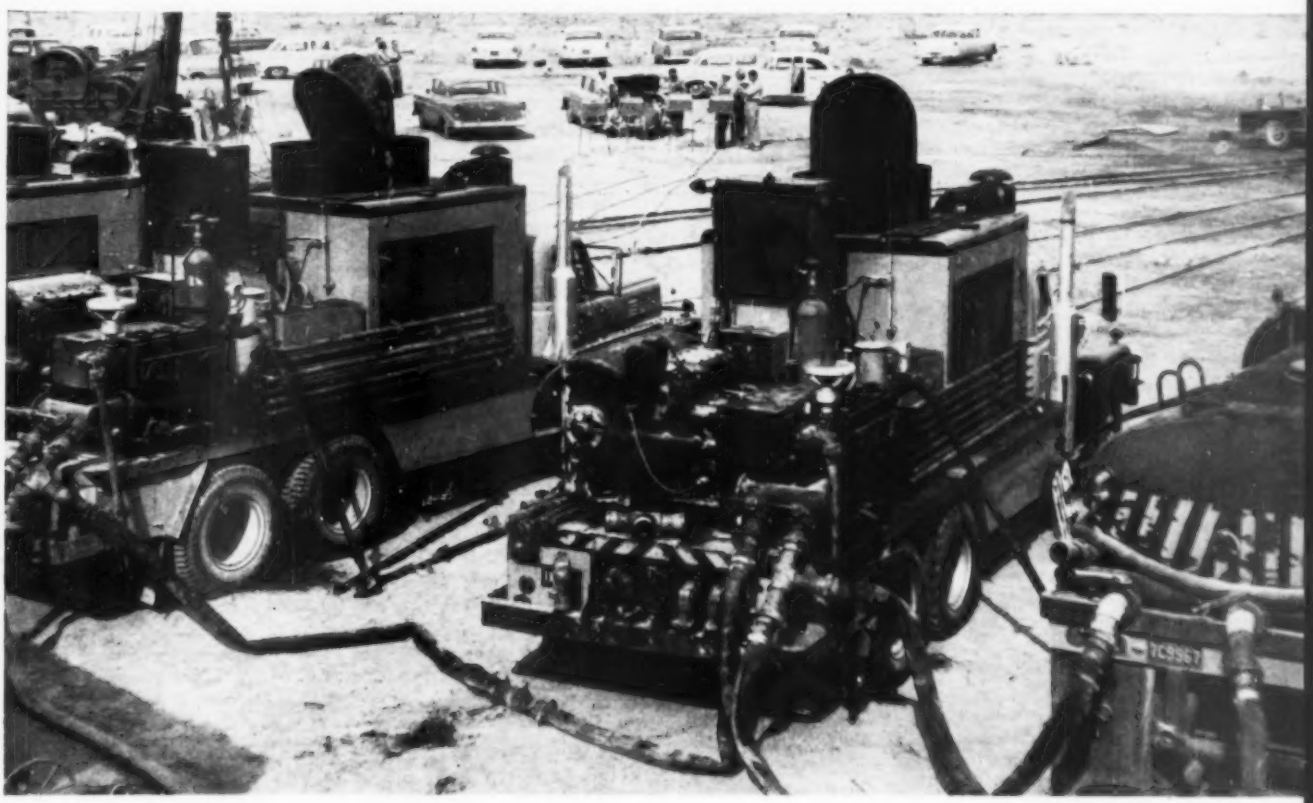
IN ILLINOIS, formations such as the Aux Vases sandstone have frequently shown good production increases when fractured with Petrojel*. The gelled crude used in this service combines good sand-carrying capacity with low friction loss. Troubles are few and, due to the low cost, many treatments pay out in less than a week.

IN EAST TEXAS, Petrofrac* is finding use on new wells completed in the Travis Peak formation. The emulsified oil used in this service combines excellent sand-carrying qualities with dependable performance. And the net cost is at a minimum, when it is considered that the operator can furnish the oil and sell it after treatment.

IN NORTH TEXAS, Frac Acid is often used in such formations as the Caddo and Canyon limes. The fracturing medium is a thickened acid. The Caddo and Canyon formations are highly soluble, and Frac Acid is designed to give deep penetration. Many of Dowell's addition agents may be added to help achieve even better results.

NEAR FARMINGTON, N. M., the Pictured Cliffs and the Mesa Verde series of gas sands respond exceptionally well to Riverfrac*. Fresh water from the San Juan river makes a low-cost, non-volatile fracturing medium. Low fluid costs make large volume treatments practical. Treatments often produce some large production increases.



IN THE PERMIAN BASIN, formations such as the Clear Fork and San Andres exhibit good acid solubility plus a surprisingly high salt content. Dowell has developed Duofrac* especially for these formations. The fracturing fluid used in this service consists of fresh water with a low-concentration of acid added. The fresh water acts to dissolve salt while the acid attacks the lime or dolomite. Dowell addition agents may be used to reduce fluid loss, and to prevent emulsions and silicate swelling. Results from Duofrac are frequently outstanding.

limitations of well temperature; it can be used in the 110 to 250 F temperature range. The consolidating plastic developed by Humble research and now being utilized in field operations also is limited by the presence of large amounts of calcium carbonate in the formation because this will neutralize the acidic catalyst. Other catalysts can be used satisfactorily in the presence of carbonate; however, they have not been employed in field operations to date. Thus far, in the coastal areas where this consolidating plastic has been applied, neither the limiting well temperature nor carbonate has been encountered.

DUAL COMPLETIONS

Only single wells have been considered thus far. However, the popularity of dual completions with their attendant increased costs and difficulties necessitates a look at sand exclusion as applied to dual completions. The lower zone of the dual completion is handled in the same manner as a single completion. Therefore, the upper zone only will be considered as a significant change in sand-exclusion techniques.

Screens. A number of dual completions have been set up with slotted or wire-wrapped screens opposite the upper zone. This is generally accomplished by resting the lower end of the screen on the top of a drillable packer located between the two producing intervals. The screen usually contains a lead seal at its lower end and a liner packer at the upper end to permit sealing the annulus between the screen and casing above and below the upper zone. The bore of the screen must be sufficiently large to pass the seal nipples that seal in the drillable packer. Production from the upper zone passes between the screen and well tubing through its appropriate path to the surface, i.e., the well tubing, casing annulus, or additional tubing. The liner packer must contain a hanger or slips that will prevent upward movement of the screen and liner. A pressure differential across the screen will tend to force it upward, and even slight movement will disrupt the lead seal at the packer permitting sand production. To assist in holding the screen in position, some installations have contained centralizers that are fastened on the well tubing and rest on top of the liner, permitting tubing weight to be placed on the screen and liner. The same precautions of completion fluid and technique must be observed in setting the screen for a dual completion as is observed with single completions.

Gravel packing. Gravel packing has likewise been used on several installations for sand exclusion of the upper zone. A screen and liner installation as previously described is incorporated with gravel, generally placed behind the screen and liner by the crossover technique. The cavity behind the upper perforations is filled by utilizing a squeeze pressure after circulating the gravel into position. The wash pipe below the crossover tool contains a seal nipple at its lower end to isolate the lower zone from the upper interval during gravel-pack operations. Gravel packing may also be performed by placing a retrievable plug in the drillable packer, performing the gravel-pack job in the conventional fashion by washing the perforations and squeezing gravel into place, and by washing the screen and liner into place until the lead seal on its lower end rests on the drillable packer. The plug in the packer may be retrieved through the screen and liner.

Plastic coated walnut shells. Plastic-coated walnut shells have been used numerous times as a method of sand control on the upper zone of dually completed wells. The technique lends itself to this type of operation because it does not require a screen and liner. The job is performed in a conventional fashion after placing a plug in a drillable packer located between the producing intervals. The aluminum-screen technique may be utilized as with single completions to form an annular ring of shells between the screen and casing perforations. The upper zone production will pass between the aluminum screen and the well tubing. No liner packer is necessary for this type of installation, and the aluminum screen need not be anchored in place by slips or hanger mechanism.

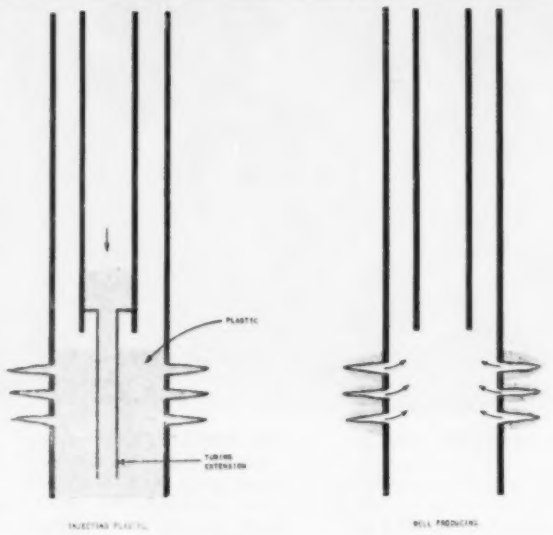


FIG. 13. Wire line method of placing consolidating plastic. Material injected down tubing extension by bradenhead squeeze (left). After setting, well is allowed to produce as shown at right.

Consolidating plastic. Consolidating plastic also lends itself to dual completions inasmuch as it does not obstruct the well bore. The process has been used a number of times in dual completions, including a technique of utilizing the retrievable production tube that permits reworking of the upper zone without a rig. This new type of dual completion, previously described in an API paper,[13] and the consolidating plastic sand-exclusion technique are very compatible. They lend themselves to installations that may be consolidated initially or in the later life of the well without the use of a rig. Thus far, the use of consolidating plastic with this type of installation has been limited to water locations. However, a number of inland dual completions have been equipped with retrievable production tubes and are ready for the use of consolidating plastic in the future, without the attendant high cost of rigs, should sand problems become serious.

MOST IMPORTANT FEATURES

Every effort should be made to insure that all perforations are open for production and the sand face is clean to reduce the velocity of fluid withdrawal. If sand producing tendencies have been established after the use of correct completion techniques, a method of sand exclusion is required. All sand-exclusion methods are enhanced by a mud-free environment, and the presence of mud almost insures failure of some techniques.

Following are some of the most important features of the sand-exclusion techniques.

1. Slotted or wire-wrapped screen.
   a. Most economical.
   b. Should be largest possible size that will go in open hole.
   c. Will reduce productivity in perforated casing.

d. Subject to corrosion and erosion and should be considered for relatively short life if sand problem is serious.
e. Subject to sand and shale movement because formation must move to bridge, and should not be used if shale stringers are prevalent and ratio problems resulting from channels are common.
f. Adaptable to through-the-tubing setting for short-duration production, particularly tests.

2. Gravel packing.
a. Economical if performed in a correct manner and with low-cost rigs.
b. Has good productivity if pack is thick and sand face is clean.
c. Fracture pressure should be used if water or oil injectivity is low, particularly as the result of shale blocking.
d. Gravel- to sand-size ratio of 4 to 6 should be used with screen slot approximately one-half that of gravel size.
e. Life of installation may be considered as approximately 5 years under normal conditions — life may be increased by consolidating gravel in place with plastic to eliminate need for screen.
f. Has limited use with wire-line technique.

3. Plastic-coated walnut shells.
a. Applicable when mud-plugged perforations are unavoidable and perforations cannot be washed; success ratio will not be high unless alumimum screen and liner is utilized.
b. Generally good productivity; acid wash may be used if well will not come in immediately.
c. Not subject to corrosion or erosion; life of installation should be good if plastic bond is obtained.
d. Holds shale and sand in place, preventing shale blocking or channeling.
e. Has had limited application with wire line—theory would indicate that the wire-line technique may best be utilized after well has produced small amount of sand.

4. Consolidating plastic.
a. Lowest cost method of sand exclusion for water locations when wire-line techniques are used.
b. Success definitely depends on clean formation and open perforations.
c. Best applied on initial completion or initial indication of sand production.
d. Bonds all formation in place to prevent shale blocking or ratio problems.
e. Long life installation.
f. Permits easier remedial operations because consolidated sand may be treated as in conventional wells.
g. May have inferior productivity in shaly, low-permeability sands.
h. Best used with wire-line technique because of simplicity; however, rig may be used if drilling mud is eliminated.

SOME SUGGESTIONS

The following conclusions can be made from observation of past and present sand-exclusion techniques:

1. Every effort should be made to ascertain if sand production can be prevented by correct completion techniques that prevent formation damage or plugging.

2. No sand-exclusion technique should be overlooked merely because of past failure. Present-day completion practices are vastly improved and permit effective utilization of old sand-exclusion methods.

3. When correctly selected and applied, a good sand-exclusion technique should prevent sand production on better than 9 out of 10 jobs.

4. Sand production can be successfully prevented with presently available methods. However, laboratory and field work should continue on new exclusion techniques and perfection of old techniques, such as consolidating plastic, to develop a long life, economical process that allows simple and effective later remedial operations.

5. With the trend to offshore and deeper inland wells, a successful sand-exclusion technique should require a minimum of personnel and equipment and as such preferably should be performed without a workover or drilling rig.

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Humble Discovery . . .

Freeport Builds Mile-Long Sulfur Mining Island

World's first offshore sulfur mining plant — believed to be the world's largest steel island — is now being constructed in the Gulf of Mexico seven miles off the coast of Louisiana.

The Y-shaped structure, nearly a mile long and rising 55 ft above the water, is the principal part of a $30,000,000 Freeport Sulphur Company project to develop a major new sulfur deposit at Grand Isle.

Discovered by Humble Oil and Refining Company, the Grand Isle deposit ranks among the most important sulfur discoveries of recent years. The mine is expected to be in production in 1960.

Five large towers will support the major installations — a seawater heating plant, three drilling platforms, and living quarters and recreational area. The Frasch process-type plant will use 13,000,000 cu ft of gas to heat 5,000,000 gal of seawater a day to 325 F for injection into the wells.

Two drilling platform units will be at the ends of the Y arms. In addition to the derricks from which directional wells will be drilled, facilities will be installed to collect and measure the sulfur coming from the deposit 2000 ft below. The third drilling platform will be some distance from the main island.

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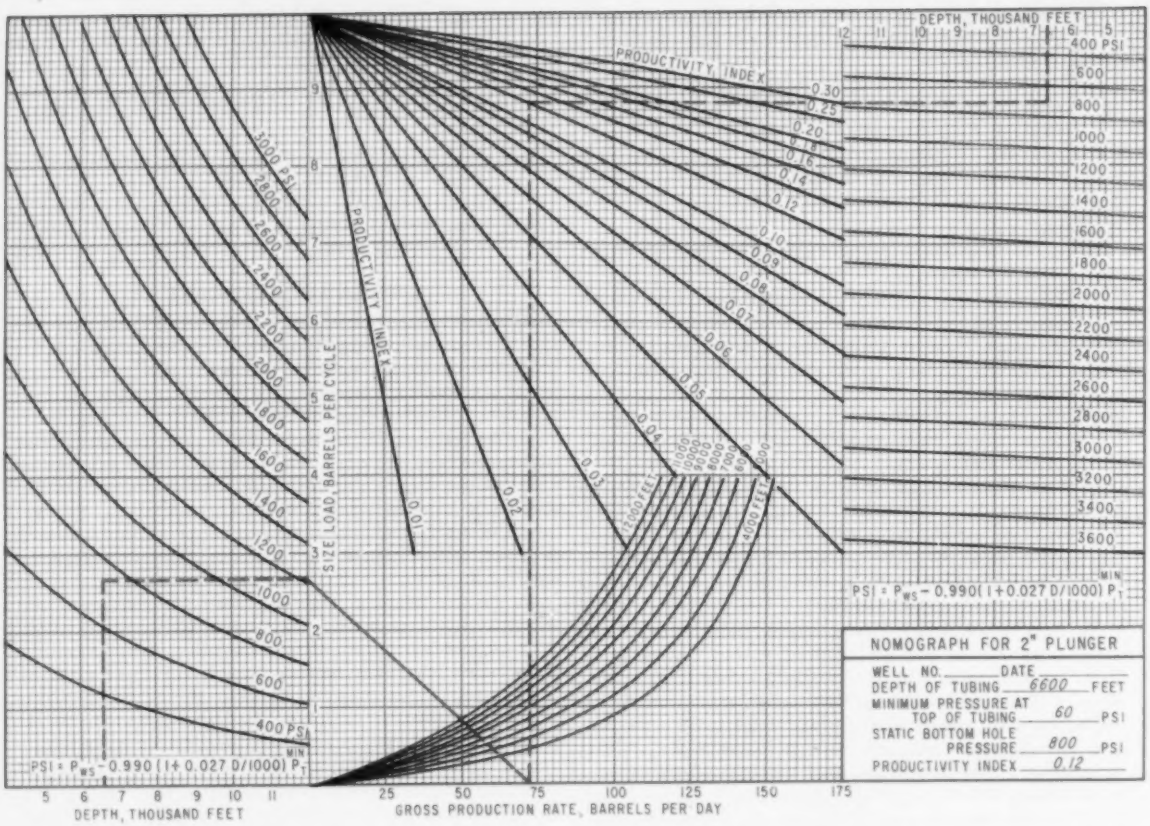
DEPTH, THOUSAND FEET
PRODUCTIVITY INDEX
SIZE LOAD, BARRELS PER CYCLE
PRODUCTIVITY INDEX
DEPTH, THOUSAND FEET
GROSS PRODUCTION RATE, BARRELS PER DAY
PSI = Pws - 0.990 (1+0.027 D/1000) Pt
NOMOGRAPH FOR 2" PLUNGER
WELL NO. DATE
DEPTH OF TUBING 6600 FEET
MINIMUM PRESSURE AT TOP OF TUBING 60 PSI
STATIC BOTTOM HOLE PRESSURE 800 PSI
PRODUCTIVITY INDEX 0.12

FIG. 1. **Nomograph for 2-in. plunger.** Example illustrated by dotted line is for a well with the following known conditions: Depth of tubing = 6600 ft; minimum pressure at top of tubing = 60 psi; static bottom-hole pressure = 800 psi, and a productivity index of 0.12.

Short-Cut Design Calculations and Field Applications of . . .

The Plunger Lift Method of Oil Production

Nomographs constructed for 2-in. and 2½-in. plungers simplify mathematical computations for operating variables

Carrol M. Beeson
Petroleum Engineering Department, The University of Southern California, Los Angeles, California

Donald G. Knox and John H. Stoddard
The National Supply Company, Los Angeles, California

PART 2 CONSTRUCTING NOMOGRAPHS TO SIMPLIFY CALCULATIONS

Need for Nomographs

HAVING OBTAINED the equations, as described earlier, the next step was to derive an expression for production rate. This could be accomplished through use of the equations for net operating pressure and pressure build-up, in conjunction with the productivity index equation. Mathematical operations indicated by the resulting expression for production rate could be simplified by constructing a nomograph. This graphical treatment would also permit ready display of the range of production rates below the maximum.

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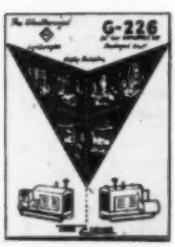

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METHOD OF CONSTRUCTING NOMOGRAPHS

Estimating Average Pressure at Point Where Gas Enters Tubing

For a cyclical process such as that involved in the free piston system, the average pressure at the point where gas enters the tubing may be estimated from the casing pressures (at the surface), in the following manner:

The average casing pressure (at the surface) may be taken as the arithmetic average of the maximum and minimum casing pressures, or the maximum casing pressure less one-half the pressure build-up. The average pressure at the bottom of the column of gas may be obtained by adding the weight of the gas. This may be done through multiplication of the average pressure at the top of the column by a factor appropriate for an average well. The resulting product may be added to the average pressure at the top.

The average well was assumed to have a gas gravity of 0.75 (referred to air), a depth of 8000 ft, and an average casing temperature of 160 F. These values led to an average gas factor of 0.027 D/1000, and to the approximate relation:

$$\bar{P}_{wf} = \left[\overset{max}{P_c} - \tfrac{1}{2} \left(\overset{max}{P_c} - \overset{min}{P_c} \right) \right] (1 + 0.027\, D/1000) \quad . \quad (14)$$

(NOTE: All symbols were defined in Part 1.)

Derivation of Operating Line for 2-in. Plunger

In obtaining an expression for production rate to construct the operating line, use was made of the productivity index equation:

$$q = J\,(P_{ws} - \bar{P}_{wf}) \quad . \quad . \quad . \quad . \quad (15)$$

Substituting the value of $\bar{P}_{wf}$ from Equation 14 into Equation 15 and rearranging yields:

$$q = J\,P_{ws} - J \left[\overset{max}{P_c} - \tfrac{1}{2} \left(\overset{max}{P_c} - \overset{min}{P_c} \right) \right] (1 + 0.027\, D/1000) \quad . \quad . \quad . \quad . \quad (16)$$

Combining the preceding with Equations 1 and 5 gives:

$$q = JP_{ws} - J\,(\overset{min}{P_t} + 77.7\,L_c + 8.29\,D/1000 + 18.08\,L_c\,D/1000 + 67.4)$$

$$(1 + 0.027\,D/1000) + \tfrac{1}{2}\,J\,(8.16\,L_c + 3.43\,D/1000 + 0.020\,\overset{min}{P_t} + 9.9)\,(1 + 0.027\,D/1000) \quad . \quad . \quad (17)$$

Equation 17 may be rearranged to express q in terms of L_c as follows:

$$q = JP_{ws} - J\,(1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t} + 6.58\,D/1000 + 62.4) - J\,(1 + 0.027\,D/1000)\,(18.08\,D/1000 + 73.6)\,L_c \quad . \quad . \quad . \quad . \quad (18)$$

Equation 18 represents a straight line, if q is plotted against L_c for given values of J, P_{ws}, D, and $\overset{min}{P_t}$. This is termed the "operating line," and it may be determined by the intercepts on the axes, which are given below:

When $q = 0$,

$$L_c = \frac{P_{ws} - (1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t} + 6.58\,D/1000 + 62.4)}{(1 + 0.027\,D/1000)\,(18.08\,D/1000 + 73.6)} \quad . \quad . \quad . \quad . \quad (19)$$

When $L_c = 0$,

$$q = JP_{ws} - J\,(1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t} + 6.58\,D/1000 + 62.4) \quad . \quad . \quad . \quad . \quad (20)$$

Derivation of Operating Line for 2½-in. Plunger

In steps analogous to those described above, expressions similar to Equations 18, 19, and 20 have been derived for the 2½-in. plunger and are listed below:

$$q = J\,P_{ws} - J\,(1 + 0.027\,D/1000)\,(0.974\,\overset{min}{P_t} + 1.125\,D/1000 + 113.2) - J\,(1 + 0.027\,D/1000)\,(11.11\,D/1000 + 1.545)\,L_c \quad . \quad . \quad . \quad . \quad (21)$$

When $q = 0$,

$$L_c = \frac{P_{ws} - (1 + 0.027\,D/1000)\,(0.974\,\overset{min}{P_t} + 1.125\,D/1000 + 113.2)}{(1 + 0.027\,D/1000)\,(11.11\,D/1000 + 1.545)} \quad . \quad . \quad . \quad . \quad (22)$$

When $L_c = 0$,

$$q = J\,P_{ws} - J\,(1 + 0.027\,D/1000)\,(0.974\,\overset{min}{P_t} + 1.125\,D/1000 + 113.2) \quad . \quad . \quad . \quad . \quad (23)$$

Mathematical Operations by Nomographs

The value of $(1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t})$ may be separated in Equations 19 and 20, and may be subtracted separately from P_{ws}. Then the intercepts are fixed by the value of D and the value of $P_{ws} - (1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t})$. The left-hand chart in the nomograph for the 2-in. plunger (Fig. 1) contains curves of the intercept by Equation 19 plotted against depth for various values of

$$P_{ws} - (1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t}).$$

The chart in the upper right-hand corner of Fig. 1 contains essentially straight lines which subtract the value of $(1 + 0.027\,D/1000)\,(6.58\,D/1000 + 62.4)$ from $P_{ws} - (1 + 0.027\,D/1000)\,(0.990\,\overset{min}{P_t})$. The radiating lines in the upper center of Fig. 1 permit multiplication of the above difference by the productivity index, to obtain intercept 2.

As the rate of production is limited by the time required for the plunger to complete a cycle, it was necessary to draw maximum production rate curves on the lower-center portion of Fig. 1. Each of these curves was plotted by substituting a given value of depth and various values of size load in Equation 7.

The above mathematical operations by the nomograph make it possible to locate graphically the two intercepts. Drawing the line between the intercepts yields the operating line which is that part of the line between intercept 1 and the point where the line crosses the appropriate maximum production rate curve.

Entirely analogous operations are performed by means of the nomograph in Fig. 2 for the 2½-in. plunger.

Derivation of Supplementary Operating Line for 2-in. Plunger

The operation of the free piston in a well with an excessive formation gas-liquid ratio may be determined by the ratio rather than by the anticipated minimum tubing pressure. Consequently, an expression was derived from the supplementary operating line, based on gas-liquid ratio gradient instead of minimum tubing pressure.

This was accomplished by obtaining from Equation 3 the

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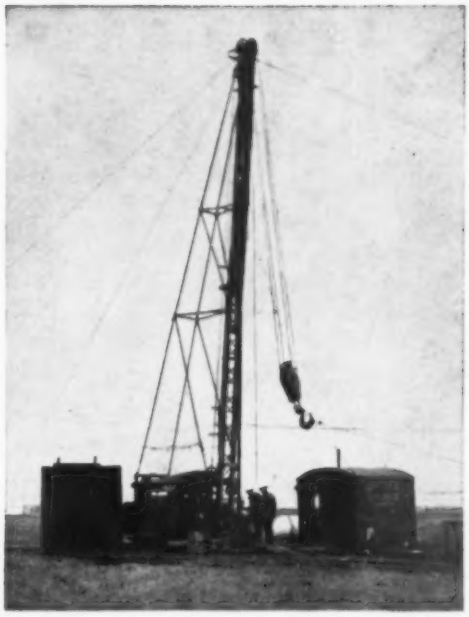
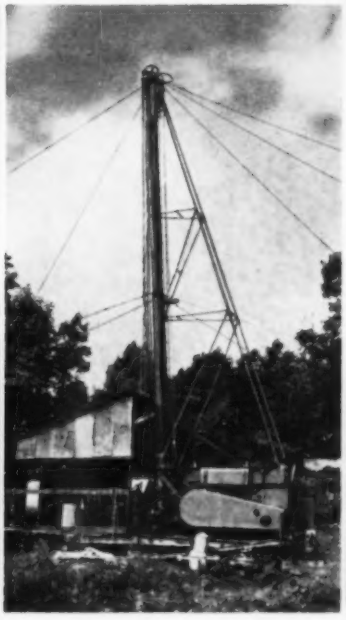


A 60-L owned by Gaines Drilling Co., El Dorado, Kans., cleans out a 1900-ft. well (about 40 years old) in a Cities Service water flood project west of El Dorado. Says Driller Mack Gaffney: "I like 'em. Bucyrus-Eries have a good snappy spudding motion." Driller Harley Nicholas adds: "I've worked a lot of rigs in different formations all over the country . . . and I like Bucyrus-Eries for their steady, trouble-free performance."

Owners of five Bucyrus-Erie spudders, Greer Bros., Whitesville, Ky. consider the 60-L as "the only rig for drilling in Kentucky". This 60-L is cleaning out a well in the Apex Field near Greenville. High line speeds assure rapid progress on hole after hole. Mobile trailer mounting, telescoping derrick, and folding tubular braces save time of moves.



A Halliburton crew runs a Hydrofrac to increase the gas flow from a 3,113-ft. well in west central Pennsylvania. Joining in the operation, Ed E. Hess, Clarion, takes advantage of the speed, strength, and capacity of his 36-L to set casing, handle tubing, and run treatment packers.

"We had all kinds of equipment," says E. M. Hale, Ada, Okla., "but we've standardized on 28-Ls for quick moving. We worked over 23 wells in six months on a water flood project with never a breakdown for either rig." Hale (extreme right) watches his men swab fracture oil and fresh crude through perforations on a well in the Wetley Field.

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value for $\overset{\text{min}}{P_t}$ and substituting in Equation 18. Rearranging to express q in terms of L_c gives:

$$q = J\,P_{ws} - J\,(1 + 0.027\,D/1000)\,(1.279\,\frac{G/L}{D/1000} + 18.08\,D/1000 - 183.5)L_c + J\,(1 + 0.027\,D/1000)\,(6.09\,D/1000) + 294) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

Equation 24 represents a straight line, if q is plotted against L_c for given values of J, P_{ws}, D, and (G/L) / (D/1000). This is termed the supplementary operating line, and it might be determined by the intercepts on the axis. It is more convenient, however, to use the intersection of the two operating lines and the intercept on the production rate axis. The latter is called intercept 2A and is expressed as follows:

When $L_c = O$,

$$q = J\,P_{ws} + J\,(1 + 0.027\,D/1000)\,(6.09\,D/1000 + 294) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

It was desirable to use the same base (psi) lines on the nomograph of Fig. 1 for determining both intercepts 2 and 2A. The chart in the upper right-hand corner of Fig. 1 contains lines which subtract the value of $(1 + 0.027\,D/1000)\,(6.58\,D/1000 + 62.4)$ from $P_{ws} - (1 + 0.027\,D/1000)\,(0.990\,\overset{\text{min}}{P_t})$. Equation 25 does not contain a term involving $\overset{\text{min}}{P_t}$, so the minimum tubing pressure is ignored in determining intercept 2A. This equation also shows that $(1 + 0.027\,D/1000)\,(6.09\,D/1000 + 294)$ should be added to P_{ws}.

To use the base lines in the upper right-hand chart (Fig. 1) as the first step in obtaining intercept 2A, it follows that the sum of the above differences, or $(1 + 0.027\,D/1000)\,(12.67\,D/1000 + 356)$, must be added to P_{ws}. In this way, P_{ws} will be increased both by the amount the lines subtract and by the amount shown in Equation 25. Thus, the measurements for intercept 2A are made from the base lines drawn for intercept 2.

The relation for the intersection of operating lines may be obtained by solving simultaneously the equations for the two operating lines. The result is the equation for gas-liquid ratio gradient which was solved simultaneously with the (main) operating line in deriving the supplementary operating line. In the case of the 2-in. plunger, the expression for the intersection is the same as Equation 3 of Part 1.

It is explained below why the intersection of operating lines will lie on the dotted extension of the (main) operating line. Also included is a graphic explanation of the fact that the intersection may be located by means of the appropriate equation for gas-liquid ratio gradient.

The only time the supplementary operating line is of interest is when the formation gas-liquid ratio gradient is greater than that required for the maximum production rate determined by the (main) operating line. Along this operating line, the minimum tubing pressure is fixed while the gas-liquid ratio gradient continually increases with decreasing size load. As a consequence, on the dotted extension of this operating line there must be a point where the gas-liquid ratio gradient required for the size load at the point is equivalent to the formation gas-liquid ratio gradient. This point is the intersection of operating lines.

Along the supplementary operating line, the formation gas-liquid ratio gradient remains constant, while the minimum tubing pressure continually decreases with decreasing size load. Consequently, on the supplementary operating line, there must be a point where the minimum tubing pressure required for the size load at the point is equivalent to the fixed value of minimum tubing pressure along the (main) operating line. This point also is the intersection of operating lines.

From the above, it follows that the lines intersect at the point where the size load has the value required by both the minimum tubing pressure of the (main) operating line and the formation gas-liquid ratio of the supplementary operating line. This size load may be computed by means of the equation for gas-liquid ratio gradient. The point corresponding to the computed size load lies on both lines, so it is readily located on the one that has already been drawn. Accordingly, the intersection of operating lines is located as the point on the (main) operating line that corresponds to the size load computed from the equation for gas-liquid ratio gradient.

Derivation of Supplementary Operating Line for 2½-in. Plunger

In steps analogous to those described above, relations similar to Equations 24 and 25 have been derived for the 2½-in. plunger and are listed below:

$$q = JP_{ws} - J\,(1 + 0.027\,D/1000)\,(1.320\,\frac{G/L}{D/1000} + 11.11\,D/1000 - 159.5)L_c + J\,(1 + 0.027\,D/1000)\,(62.0\,D/1000 + 222) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 26)$$

When $L_c = O$,

$$q = J\,P_{ws} + J\,(1 + 0.027\,D/1000)\,(62.0\,D/1000 + 222) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

In using the lines in the upper right-hand corner of Fig. 2 as the first step in determining intercept 2A, the value that should be added to P_{ws} is $(1 + 0.027\,D/1000)\,(63.1\,D/1000 + 335)$. When locating the intersection of operating lines for the 2½-in. plunger, Equation 4 should be used.

TESTING EFFECTS OF VARIOUS WELL CONDITIONS

The effects of change in tailpipe, water cut and oil gravity were tested by the method of least squares and found to be insignificant. The method was applied to the net operating pressure and to the cycle gas gradient, for the wells with 2½-in. plungers, as has been described below.

After obtaining Equations 2 and 11, the method of least squares was applied again with one of the well conditions as an added independent variable. In this way, new coefficients of the variables and a new coefficient of multiple correlation were determined.

In each case, the coefficient or index of multiple correlation was found to increase so slightly, if at all, that the added variable did not significantly increase the correlation. Consequently, it was believed unnecessary to apply the test to the pressure build-up for the 2½-in. plungers or to any of the factors of pressure or gas for the 2-in. plungers.

Tailpipe

A well was considered to have a tailpipe, if a pipe extended below the footpiece by a distance equal to 0.3 percent or more of the distance from the surface to the bottom of the pipe. By this definition, 44 of the wells with 2½-in. plungers had tailpipes ranging from 0.3 to 27.7 percent, and averaged 3.25 percent.

As stated earlier, the least-squares equation for net operating pressure, which was obtained from the 75 wells with 2½-in. plungers, had an index of multiple correlation of 0.945. When tailpipe was included as an added first-power variable, the index of multiple correlation was raised to 0.946. This increase in the index is negligible because these values yield a partial co-efficient of multiple correlation that is not significant.[1]

The least-squares equation for cycle gas gradient, which was obtained from the 74 wells with 2½-in. plungers, had a coefficient of multiple correlation of 0.639. After includ-

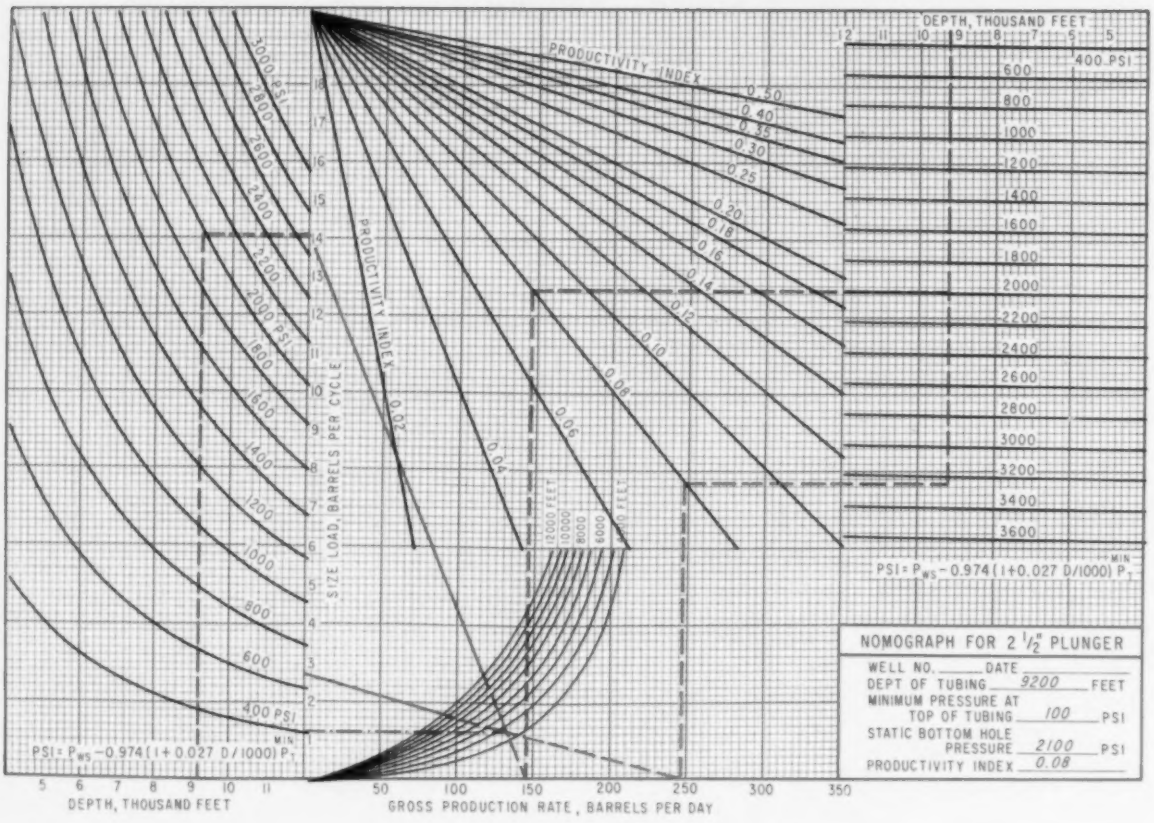
DEPTH, THOUSAND FEET
PRODUCTIVITY INDEX
SIZE LOAD, BARRELS PER CYCLE
PSI = P_{WS} − 0.974 (1 + 0.027 D/1000) P_T MIN
NOMOGRAPH FOR 2 1/2" PLUNGER
WELL NO. _____ DATE _____
DEPT OF TUBING 9200 FEET
MINIMUM PRESSURE AT TOP OF TUBING 100 PSI
STATIC BOTTOM HOLE PRESSURE 2100 PSI
PRODUCTIVITY INDEX 0.08
DEPTH, THOUSAND FEET
GROSS PRODUCTION RATE, BARRELS PER DAY

FIG. 2. **Nomograph for 2½-in. plunger.** Example illustrated by dotted line is for a well with the following known conditions: Depth of tubing = 9200 ft; minimum pressure at top of tubing = 100 psi; static bottom-hole pressure = 2100 psi, and a productivity index of 0.08.

ing tailpipe as an added first-power variable, the coefficient of multiple correlation was found again to be 0.639.

The definition of depth which is used throughout this article is the distance from the surface to the point at which gas enters the tubing. This would be at the bottom of any tailpipe. The negligible increase, if any, in the coefficients of multiple correlation indicate that no additional notice need be taken of tailpipes similar to those in the wells studied.

Water Cut

All of the equations developed in this paper include the water in the units of barrels per day and barrels per cycle. Nevertheless it was believed advisable to test the effect of water cut on the requirements of pressure and gas.

The least-squares equation for net operating pressure, which was obtained from the 75 wells with 2½-in. plungers, had an index of multiple correlation of 0.945. When water cut was included as an added first-power variable, the index of multiple correlation was found again to be 0.945.

The least-squares equation for cycle gas gradient, which was obtained from the 74 wells with 2½-in. plungers, had a coefficient of multiple correlation of 0.639. The water cut, as volume percent of total production, was included as an added first-power variable. The coefficient of multiple correlation was then found to be 0.641.

This increase in the coefficient is negligible,[1] so water cut may be ignored in estimating lift requirements. Of course, the produced water must be included in the production rate and in the size load.

For the 75 wells with 2½-in. plungers, water cuts ranged from 0 to 88.9 percent, with an average of 12.6 percent.

Oil Gravity

The least-squares equation for net operating pressure, which was obtained from 75 wells with 2½-in. plungers, had an index of multiple correlation of 0.945. After including oil gravity as an added first-power variable, the index of multiple correlation was found to be 0.947. This increase in the index is negligible.[1]

The least-squares equation for cycle gas gradient, which was obtained from the 74 wells with 2½-in. plungers, had a coefficient of multiple correlation of 0.639. When oil gravity was included as a first-power variable, the coefficient of multiple correlation was found to be 0.678. This increase in the coefficient is not significant[1] because these values yield a partial coefficient of multiple correlation of 0.029 which is not significant even for a total number of observations as high as 74.

For the oils produced from wells with 2½-in. plungers, the gravities ranged mainly from 24 to 46 deg API (one value was 21 deg), averaging 33.7 deg API. Consequently, no allowance need be made for this property in lift calculations, for oil gravities from 24 to 46 deg API.

Reference

1. Davies, O. L.: *Statistical Methods in Research*, Oliver and Boyd, London, England (1949).

TO BE CONTINUED

Part 3 "How to Use Nomographs to Estimate Performance" of this 5-part series will appear next month.

You are jetting away money uselessly — if you aren't using the HOMCO Closed Circuit Dual Centrifuge. 16 pound mud costs from ten to twenty dollars per barrel. Are you jetting these barrels of dollars away? The HOMCO Closed Circuit Dual Centrifuge reclaims the barite, the emulsion, the chemicals, the water and DISCARDS ONLY THE DRILLED SOLIDS.

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FORMATION EVALUATION BY SONIC LOGGING

New tool provides qualitative interpretation by visual inspection. Porosity determinations possible in all formations. High degree of accuracy substantiated by core analysis

W. P. Biggs
Schlumberger Well Surveying Corporation
Houston, Texas

THE SONIC LOG—measuring the sound transmitting properties of formations — has become an important tool for correlation and reservoir evaluation. It is a continuous velocity log that has been engineered to provide data for formation and reservoir study. The recorded curve still provides the geophysicist with valuable velocity data, but its more important application is as an aid to geologist and engineer. Excellent porosity values, particularly in limestones and compacted sands, can be obtained from a measurement of formation velocities. In addition, difficult correlation problems in evaporite and low porosity formations are being solved with the sonic log.

Geophysical Background

For a number of years the velocity of sound through the earth has been an important geophysical parameter. Measurement of this parameter has been accomplished by various devices designed to provide the geophysicist with data that would permit him to better understand and more accurately position reflections on his records. Early instruments consisted almost exclusively of listening devices that, after being accurately positioned in a well, received a signal caused by an explosion on the surface. These time intervals, from the instant of the shot to the reception of its signal at the receiver, were taken at various depths in the well and plotted to give an overall profile of formation velocities.

The long interval velocity survey was developed to provide a less time consuming and less expensive means of determining the velocities of the earth. In this system the overall travel time is obtained by the summation of accurately measured travel times across successive intervals throughout the length of the open borehole. The tool for this survey consists of a suitable sound source, such as a perforating gun, and two geophones located on the cable above the gun. Typical combinations of geophone intervals from the gun are 400 ft and 800 ft. The gun is surface controlled and allows as many as 48 shots per trip in the hole. When used with several casing "tie-in shots" the long interval method provides a relatively fast and accurate method of evaluating seismograph records. These long spacings, while advantageous from the geophysicist's point of view, do not readily lend themselves to the bed definition and resolution that is required for reservoir evaluation.

What is the Sonic Log?

The sonic log is a short spacing continuous velocity log that is run to provide detailed bed definition. The logging tool, as described in this paper and illustrated in Fig. 1, was developed by Humble Oil and Refining Company and further engineered by Schlumberger Well Surveying Corporation. With it either a one-foot or three-foot spacing may be run. The spacing may be changed by means of an electrical relay that functions whether the tool is on the surface or in the well. In addition to the interval transit time an SP or gamma ray curve is simultaneously recorded. These latter curves provide lithological information and establish absolute depth control for comparison with other logs run in the same well.

Two Receiver System

With spacing sufficiently short for bed definition the time required for the sound travel through the mud becomes proportionately large. This "mud time" occurs during the travel of sound from the transmitter to the wall of the hole and from the wall of the hole to the receiver. The velocity of sound through mud will depend upon the mud type, density, temperature, and pressure, but will be less than one-half the velocity

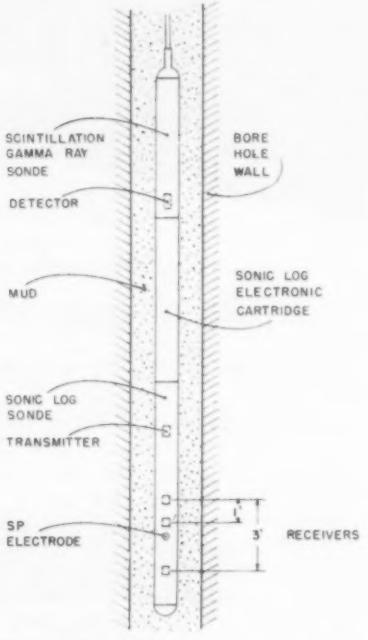


FIG. 1. **Sonic logging tool** uses two receivers, at either 1 or 3 ft spacing, changed by electrical relay functioning either in the well or at the surface. SP or gamma ray curves may be simultaneously recorded for log correlation.

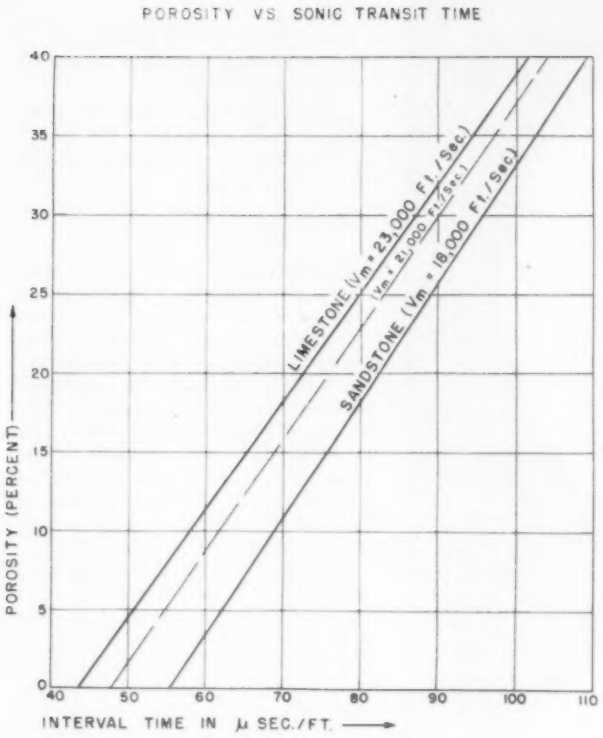

POROSITY VS. SONIC TRANSIT TIME
POROSITY (PERCENT)
INTERVAL TIME IN μ SEC./FT.
LIMESTONE (Vm = 23,000 Ft./Sec.)
(Vm = 21,000 Ft./Sec.)
SANDSTONE (Vm = 18,000 Ft./Sec.)

FIG. 2. **Linear relationship** between formation velocity and porosity is expressed here. Value of V_f is assumed as 5300 ft per sec.

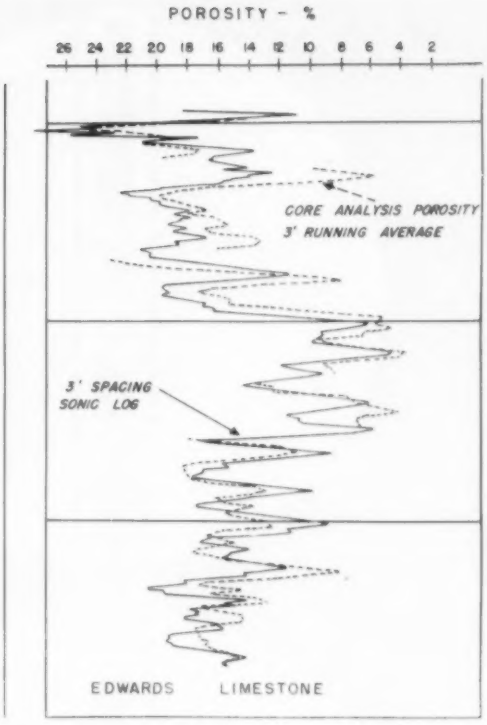


FIG. 3. **Excellent agreement** between sonic log and porosity from core analysis in the Edwards limestone. For this plot a matrix velocity of 21,000 ft per sec was used.

through a compacted reservoir formation. To eliminate errors that might thus arise the sonic log uses two receivers. The time interval that is recorded is the difference of arrival of the sound signal at each of the receivers. By this means the mud time from the transmitter to the wall of the hole is eliminated completely. As long as the two receivers are the same distance from the wall of the hole their mud times will be equal and will cancel. The influence of the mud character and hole size is, therefore, negligible as long as the tool is held parallel to the wall of the hole. Centralizers are provided for this purpose.

How Does it Work?

Ten times or more per second the magneto-striction type transmitter emits a short pulse of sound energy. The receivers are triggered by the first detectable arrival of this signal and cause a direct current voltage to be transmitted to the surface. This voltage is directly proportional to the time required for the sound to travel through one foot of formation, and is, therefore, inversely proportional to the velocity through the formation. In some instances it will be advantageous to refer to interval transit time and in others to refer to velocities.

Formation velocities range from 5000 ft per sec in recent unconsolidated beds to 25,000 ft per sec in some dense zones. These velocities correspond, respectively, to interval transit times of 200 microseconds per ft and 40 microseconds per ft. The sonic log is linearly scaled in terms of interval transit time. Since the minimum possible interval transit time is 40 microseconds the recorded curve is zeroed such that the dead space, between zero and 40 microseconds, falls off the page. This enables a more detailed scale to be recorded.

The device is run in fluid filled and uncased wells. Excellent results are obtained in either oil or water-base muds. Since the velocity of sound through metal is higher than through most porous reservoirs, the tool is primarily confined to open hole logging.

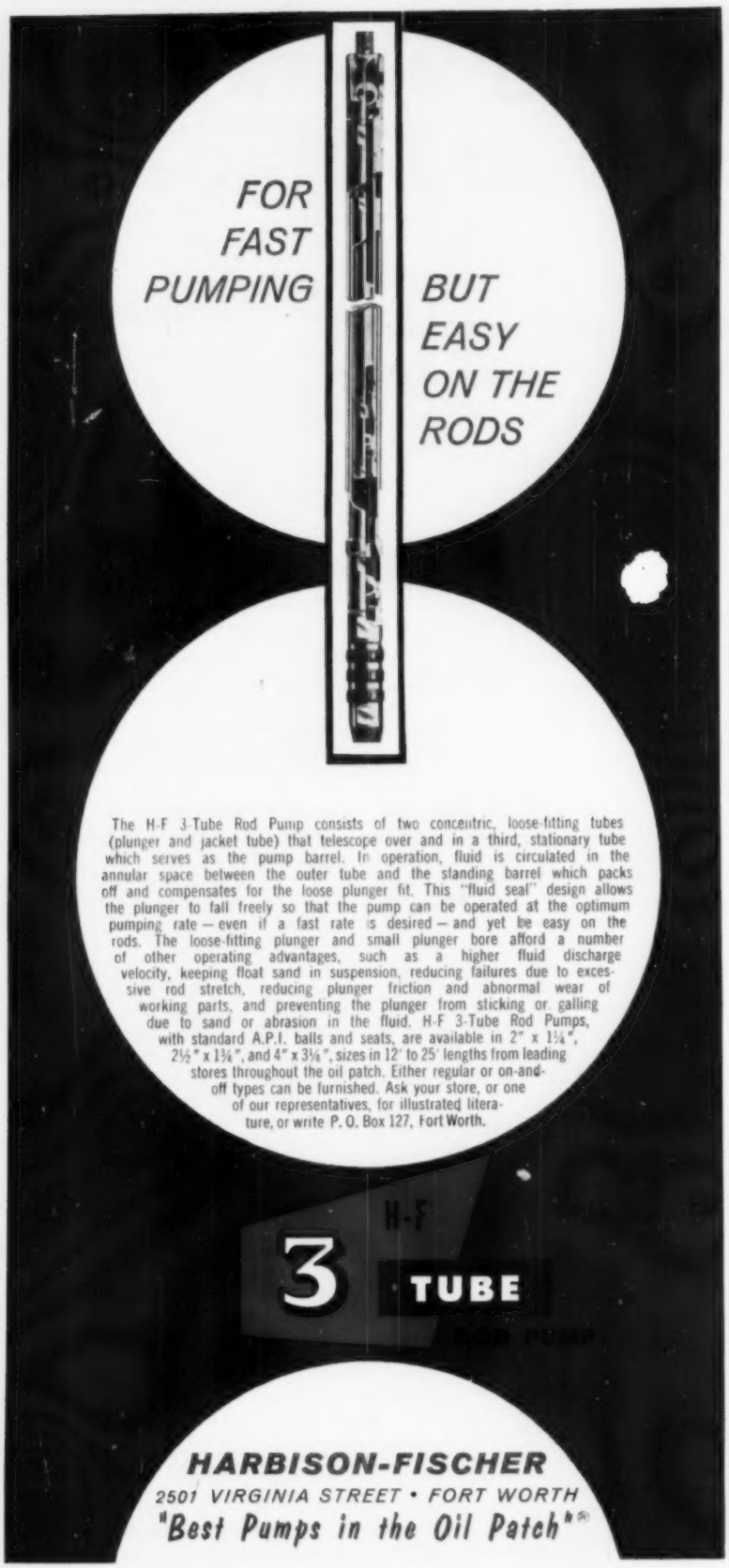
Porosity Determination

Formation velocities are functions of the density and elastic parameters of rocks. These parameters are, in turn, functions of the porosity, chemical and mineralogical content, saturating fluids, degree of lithification, reservoir pressure, overburden, temperature, and grain size. In spite of the imposing array of variables, field tests have shown that porosity changes have a dominant influence on velocity variations for a given type of rock, particularly in producible formations. A simple linear relationship between formation velocity and porosity has been proposed by M. R. J. Wyllie and has been successfully used for reservoir evaluation. The relation is:

$$t = \frac{1}{V} = \frac{\phi}{V_f} + \frac{1-\phi}{V_m}$$

The Author

W. P. Biggs *is an engineer in the field development section of Schlumberger Well Surveying Corporation's sales department in Houston, Texas. He is a 1942 aeronautical engineering graduate of Texas A&M College, joining Schlumberger as a field engineer in the Gulf Coast and South Texas areas. Biggs has served as district manager at Pleasanton, Texas, from 1952 until his recent transfer to the company's field development section.*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The H-F 3-Tube Rod Pump consists of two concentric, loose-fitting tubes (plunger and jacket tube) that telescope over and in a third, stationary tube which serves as the pump barrel. In operation, fluid is circulated in the annular space between the outer tube and the standing barrel which packs off and compensates for the loose plunger fit. This "fluid seal" design allows the plunger to fall freely so that the pump can be operated at the optimum pumping rate — even if a fast rate is desired — and yet be easy on the rods. The loose-fitting plunger and small plunger bore afford a number of other operating advantages, such as a higher fluid discharge velocity, keeping float sand in suspension, reducing failures due to excessive rod stretch, reducing plunger friction and abnormal wear of working parts, and preventing the plunger from sticking or galling due to sand or abrasion in the fluid. H-F 3-Tube Rod Pumps, with standard A.P.I. balls and seats, are available in 2" x 1¼", 2½" x 1¾", and 4" x 3¼", sizes in 12' to 25' lengths from leading stores throughout the oil patch. Either regular or on-and-off types can be furnished. Ask your store, or one of our representatives, for illustrated literature, or write P. O. Box 127, Fort Worth.
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Where:

t = Time, seconds per ft.

V = Average measured velocity (ft per second).

ϕ = Fractional Porosity (percent).

V_f = Velocity of interstitial fluid (ft per second).

V_m = Velocity of matrix (ft per second).

A graphical plot of the above expression is given on Fig. 2. In this plot a value of V_f is assumed as 5300 ft per sec. This value approximates the velocity that would be obtained in normal mud filtrates. Actually, the velocity of such filtrates would depend upon their salinity, pressure, and temperature, but the effect of such variables is not severe. Salinity and temperature differences are important in resistivity measurements but can be ignored in most cases in the use of the sonic log.

The linear plot of interval time versus porosity is shown for three different values of V_m — matrix velocity. In limestones the matrix velocity is found to vary between 20,000 and 25,000 ft per sec. Local experience will indicate the most appropriate figure for effective porosity determination. The example in Fig. 3 illustrates the excellent agreement between sonic log and porosity from core analysis in the Edwards limestone. For this plot a matrix velocity of 21,000 ft per sec was used. Sandstones, and sands that are relatively shale free and compacted, agree very well with the plot for V_m equal to 18,000 ft per sec. Corrections must be applied to the chart values of porosity when the lack of compaction or the effect of the shale becomes important.

Although relatively little experience exists, many people feel that the sonic log is presently the best porosity tool for consolidated formations. As compared with the neutron log, the sonic log has a short and a definite spacing. Only the formation that lies between the receivers affects the reading. The sonic log has a fixed zero and a linear scale, can be recorded at faster logging speeds, and is not affected by statistical variation, or by the type of mud or the hole diameter. The presence of gypsum does not have the adverse effect on the sonic log that it does on the neutron. In the example in Fig. 4, the sonic and neutron logs are compared with porosity from core analysis. The thin, low porosity streaks are dolomite beds where, it seems, the neutron characteristically gives optimistic porosity values. With the many advantages that the sonic log exhibits over the neutron log it is possible that the device will become the most commonly used porosity tool in hard and compacted formations.

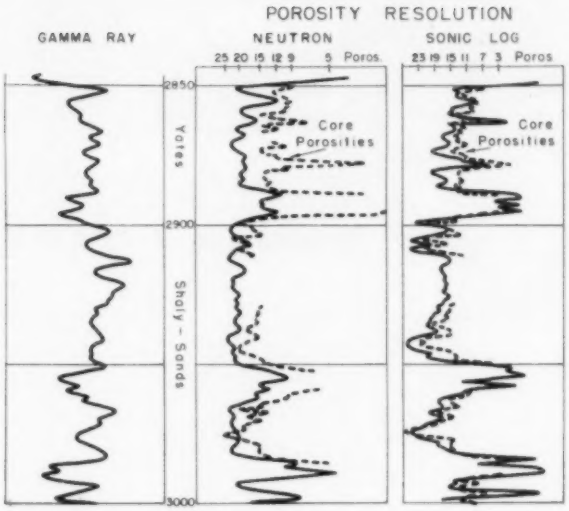

FIG. 4. **Sonic and neutron logs** are compared with porosity from core analysis. Low porosity dolomite beds shown on the sonic log are recorded, seemingly, as being more porous on the neutron log.

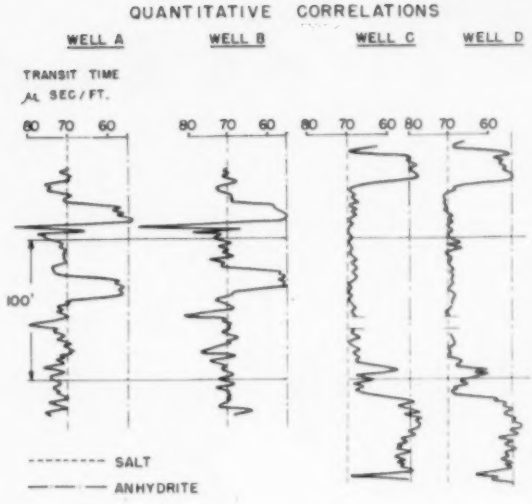

FIG. 6. **Good delineation between salt and anhydrite** is shown here, illustrating the sonic log's ability to differentiate between the two, particularly difficult for resistivity and radioactivity devices.

Detection of Hydrocarbons

The sonic log provides a different approach to the evaluation of the porosity and, as a result, to the formation factor of possibly productive zones. In low porosity formations the conditions are such that residual hydrocarbons in the flushed zone can be ignored; porosity values may be read directly from the simple linear relation chart. With higher porosity sands the presence of oil or gas close to the well bore frequently causes a noticeably lower velocity that results in a higher apparent porosity. This evolves from the fact that both gas and oil have lower velocities than mud filtrate. In this connection, the sonic log is the only porosity determining device that gives a higher apparent porosity when hydrocarbons are present. The microlog, microlaterolog, and limestone lateral values of porosity are decreased by the presence of hydrocarbons and neutron porosities are reduced by the presence of gas. This feature is illustrated by the hypothetical example in Fig. 5. These apparent discrepancies can be very beneficial in the location of productive zones and in the definition of fluid contacts.

Correlation

Geologists are often plagued with difficult correlation problems in hard formations. Particularly in these conditions the resistivity and radioactivity devices often fail to give sufficient differentiation for accurate correlations. In many such instances the sonic log has made effective correlations possible. An example of conditions that are particularly difficult for resistivity and radioactivity devices is that case where alternate beds of salt and anhydrite are encountered. The sonic log readily differentiates between the two and provides excellent correlative information (see Fig. 6). Since both the resistivity and radioactivity logs react to porosity changes there should be little difficulty in general correlation of the sonic log with either. More detailed correlations, however, will be possible when comparing sonic log with sonic log.

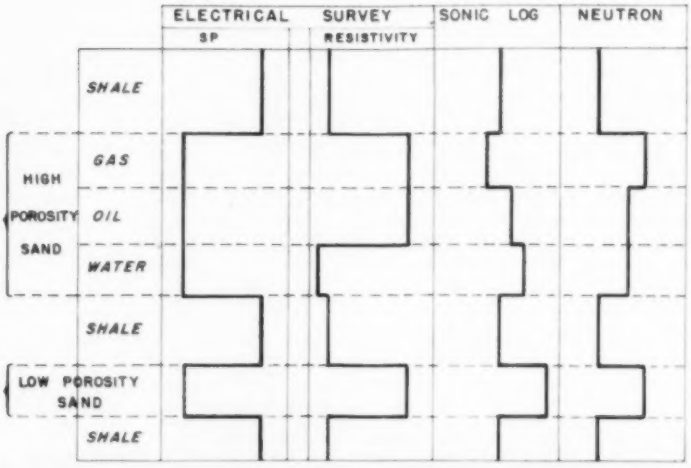

FIG. 5. **Typical reactions** of the sonic log, neutron and electrical survey. Since each log measures a different parameter, excellent qualitative interpretation is made possible.

Summary

Porosity determination, particularly in the hard and compacted formations, can be easily performed with the sonic log. Comparison of results with core analysis indicates that the accuracy of these porosity determinations is exceptionally good.

In the higher porosity formations the device furnishes qualitative information on formation fluids, particularly when compared with other porosity evaluating services.

Experience with this new tool for geologist and engineer is still limited, but interest in its use is growing at a rapid rate. Field results have been impressive and the device will undoubtedly be an important adjunct to reservoir evaluation by logging methods.

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3. *The Fundamentals of Electric Log Interpretation*, (1957) Second Edition, Academic Press, Inc., Pages 114-127.
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★ ★ ★

ORANGE FIELD

45 Years Later

Derricks still mark Orange field today, as shown in the photo at right, as it did in 1923 when the above picture was taken of a well blowout and fire.

Domal flank possibilities embellish hopes for new life in this old Upper Coastal Texas field, still gaging 1,000,000 bbl of oil annually — years beyond its predicted life span

Geneos Pete Cokinos
Petroleum Engineer,
Texas Railroad Commission,
Beaumont, Texas

THERE IS A POINT in the life of a producing oil well whereby a decision lies with management whether or not to continue operating the well or to take abandonment proceedings even though the well may still be making oil.

Salvaging a well because the lifting cost of a well is beyond the profit point and in the loss column is the conventional solution. It just makes good sense from a dollars and cents standpoint to abandon a well that is operating at a loss and to take what salvage material can be recovered. From an ultimate recovery standpoint, it is difficult to convince the uninitiated that a well should be abandoned that is still producing oil.

It goes without saying that strange as it may sound to the eastern feature and magazine writers one can own an oil well and go broke. Owning an oil well does not automatically make one a millionaire.

A case in point is the Orange field dome, a typical Texas-Louisiana salt dome oil field, that has gone through the cycle of flush, boom oil production with major companies leading the way. Thence, it has aged into that stage of its oilfield life whereby sand and salt water are produced in about the same quantities as the oil. This is where lifting cost is on the upgrade and the profit realized by the oil producer has been reduced.

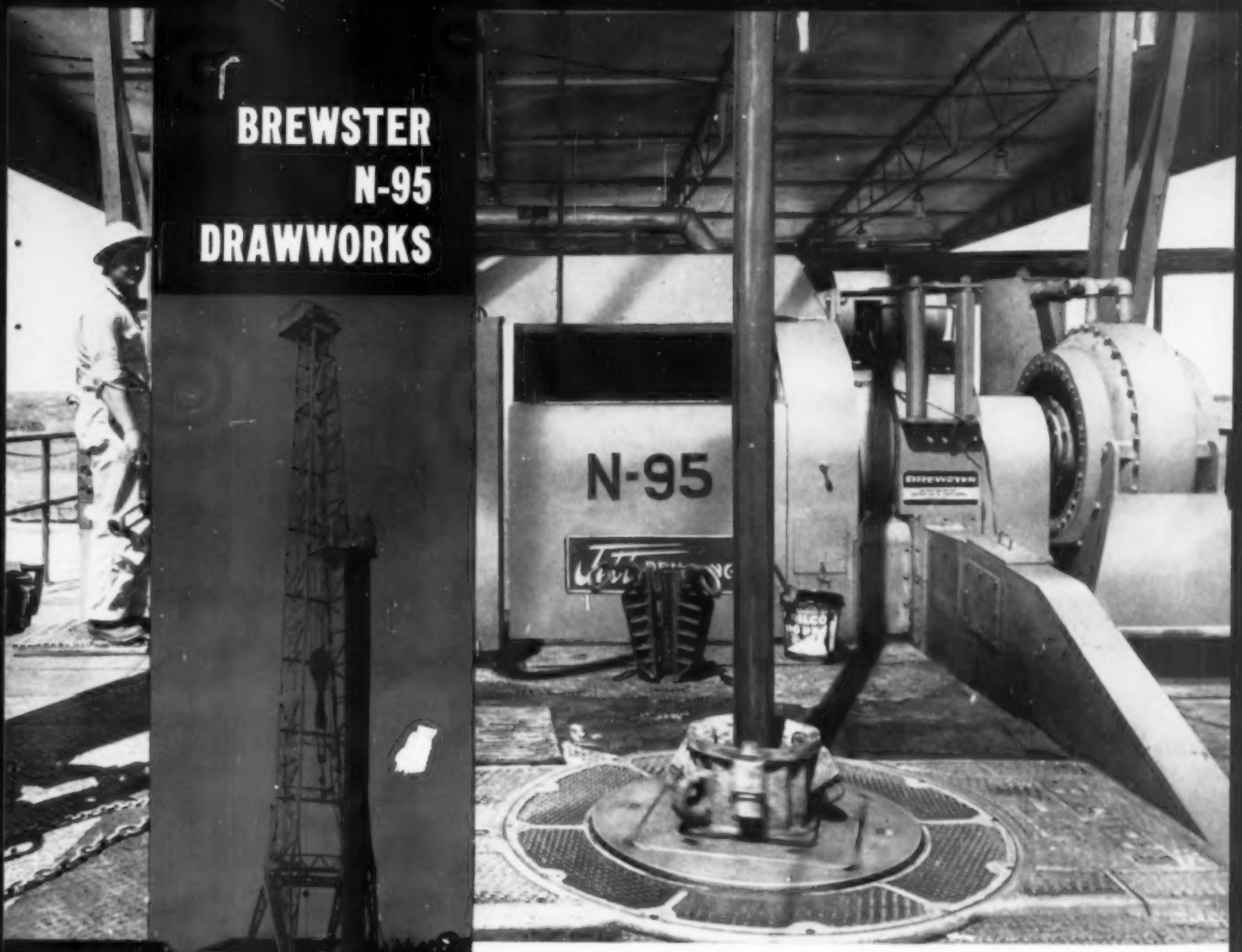
This is the side of the oil business that goes by unpublicized and unheralded save for the service company representatives and workover rigs that work with the oil producer. Usually it reaches a point whereby the oil operator himself is fighting the lifting cost battle in the field with perhaps just enough roustabouts to keep the operation from being in the red. This is the side of the oil business that is perhaps the meanest.

For evidence, visit any of the old oil fields such as Orange field on any given day . . . or better yet, follow a workover crew for a few days.

In Orange field there is a day-to-day struggle in trying to produce oil ready for pipeline purchase ONLY after the salt water has been treated from the fluid produced ONLY after a "sanded-up" dead well has had a remedial workover job ONLY after the workover or sand-control job has been proved successful (from a production standpoint). On the average, an Orange field well will have about 20 rod jobs and 6 tubing pulling jobs a year. Oil operators in Orange field for the last 10 years (when the last major oil company pulled stakes) are today producing more than 100,000 bbl a month of pipeline oil. During the year 1956 Railroad Commission records reveal that Orange field produced 1,635,782 bbl. The accumulative production since date of discovery is placed at 41,220,626 bbl.

Oil is being recovered today that might as well not been ever produced. This is in the public interest and from

BREWSTER N-95 DRAWWORKS



JETT DRILLING COMPANY, INC. Rig 110 with a Brewster N-95 drawworks is now on its third 14,000-foot well.

You hear Brewster customers everywhere use this phrase when they describe the Brewster N-95 drawworks. From pump drives to drum it has been designed to take it on the chin and come up ready for even tougher going. Rated for 12,000-foot plus drilling, the N-95 has the reserve power to go on down profitably.

Flexible in design, the N-95 moves, operates economically and can be used on wells usually drilled by much smaller equipment. The drawworks is side skidded and can be separated from the compound by disconnecting one chain. The controls, auxiliary brake and drawworks move as a single unit without any disassembly.

Brewster Drawworks are built to do the job for which they are sold . . . they're not little rigs "built-up" or big rigs "cut down."

Check these exclusive features that you get ONLY when you buy a Brewster N-95 — (See next page)

RUGGED IRON

Two-Fisted Tough

EASY DOES IT . . . when it's a Brewster control panel. Full air operation plus simplicity in design leaves the driller free to follow the crew as they make a connection.

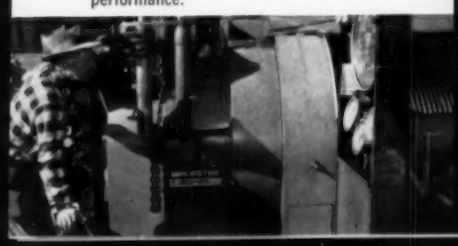
BREWSTER

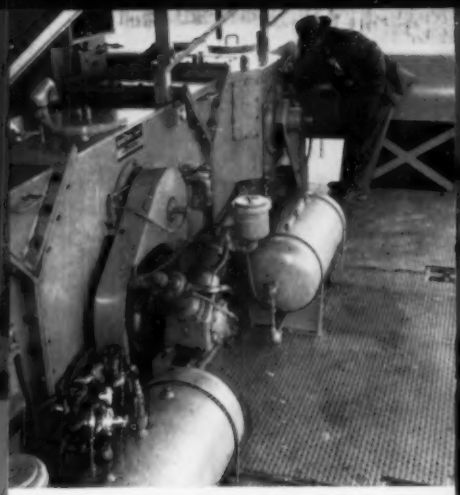
GOOD HOUSEKEEPING and good rig layout go hand in hand to make fast, safe and efficient operation on Jett Rigs.

SCHEDULED MAINTENANCE means dependable operation. The crew here is subricating linkage on the big 46" hydromatic N-95 brakes.

NON-SKID, flat surface of the Brewster 27-inch oil-bath table provides safe footing for the crew.

TOOLPUSHER, E. M. RODGERS takes over controls for a "first hand" check out on rig performance.





HEAVY DUTY COMPOUND on the N-95 prevents wear on chain, bearings and engine couplings through positive alignment and rigidity.

JETT DRILLING COMPANY, INC.

RIG 110

One of 7 Brewster drawworks operated by Jett Drilling Company, Inc., of Shreveport, the N-95 on Rig 110 is now completing its 3rd 14,000-foot well. In all the Company is operating 12 rigs; three are leased and all others are Jett owned.

Jett Drilling's remarkable growth is firmly based on sound operating policy, good men and the finest available equipment. This is why the last two rigs purchased have been Brewster N-95's and why the rotary tables, swivels and blocks are all Brewster matched equipment.

SUPPLY HOUSES

Howard Supply Company • Apex Equipment Company • Bovaird Supply Company • Industrial Supply Company • Murray Brooks, Inc. • United Supply and Manufacturing Company • Export Sales: The Brewster Company • (HOMCO) Houston Oil Field Material Company, New York, N. Y., Houston, Texas; Mexico City, D. F.

SIMPLIFIED mud pump manifolding and clean layout are naturals with Brewster's dual in-line pump drive arrangement.

BREWSTER N-95

THE BREWSTER COMPANY, INC.
Shreveport, Louisiana

1200 horsepower is available to the driller from these three LRZBU engines.

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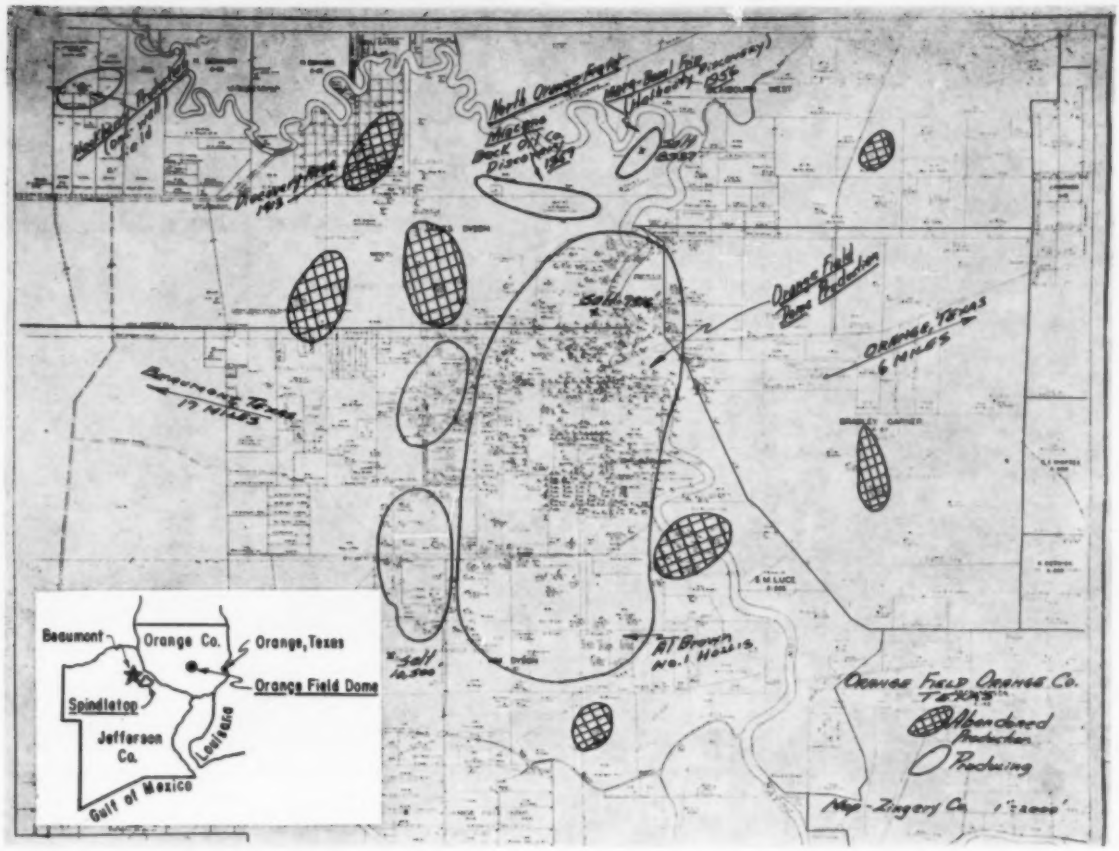


Extent and location of the Orange field on Cow Bayou 17 miles southwest of Beaumont, Texas, and 6 miles west of Orange, Texas, near the Texas-Louisiana border. The field, overlying a large salt dome, has produced over 41 million bbl to date, and is currently producing in excess of 100,000 bbl per month.

a conservation standpoint equally as great as any pressuring maintenance ever introduced to any field such as the great East Texas oil field where 5 billion bbl will be recovered in addition to the 1 billion bbl at first expected. This is in the public interest.

Orange field is a good example of a field given up for dead only to hang on and to continue to produce beyond its "point-of-no-return."

Redrilling of abandoned leases, with the added feature of modern completion methods, plus better depth control, have served as a means of continuing the activity in the oil field. Lifting costs per barrel have varied but currently averages $1.25.

TABLE 1. Operators and Production Data, Orange Field, Orange County, Texas. Average Monthly Figures (1958)

	No. of Leases	No. of Oil Wells	Production bbl/month
Beck Oil Company	1	2	1,582
Bowles, W. V. & Co.	9	30	16,817
Brown, Al	2	4	4,824
Brown, C. J.	5	7	758
Brown, Clifford L., Jr.	2	5	1,506
Cormier, Paul	10	35	14,522
Gardes, A. H. Trustee	2	10	174
L. B. Greenbaum	2	6	964
Halbouty, Michel T.	2	6	6,514
Kadane-Brachman	1	26	24,185
Karsten, Floyd L.	3	4	2,158
Kilmarnock Oil Co.	12	38	17,926
Levingston Ship Building Co.	1	1	510
McBride, R. B.	1	1	130
Oil & Gas Property Management	3	10	3,035
Providence Petroleum Corp.	2	4	2,451
The Texas Co.	1	1	238
Texkan Oil Co.	26	58	28,450
TOTAL		248	126,744

Location

Orange field is located on Cow Bayou in Orange County 17 miles southeast of Beaumont, Texas, and 6 miles west of Orange, Texas. The name of "Orangefield" was adopted by the little community filtered in and out of the field.

The salt dome occupies portions of the William Dyson, James Dyson, S. M. Luce, and the Bradley Garner surveys.

Orange field dome is approximately 8 miles due east of another Orange County salt dome, the Port Neches dome.

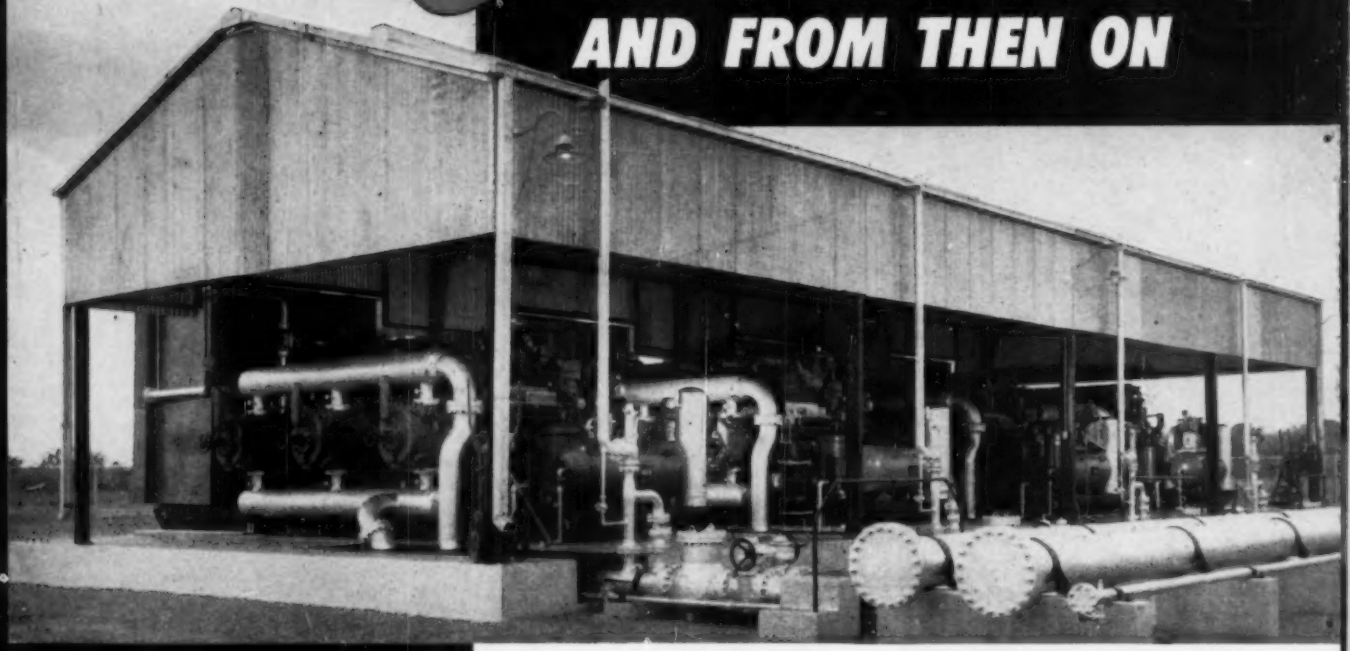
Cow Bayou is a small bayou that comes in from the northwest and winds around the northeastern portions of Orange field and takes a south course to the Gulf.

There are a number of wells deviated under the bayou which is a State of Texas lease from which oil royalty for the State of Texas is received.

Discovery History

Orange field was discovered on August 17, 1913, by the Rio Bravo Oil Company No. 1 Josh Bland flowing 150 bbl of pipeline oil per day with a

Save ON FIRST COSTS AND FROM THEN ON



Industrial Gas Supply Corporation, Needville, Texas, Compressor Station.

Southwest packaged gas compressors for main line stations

Illustrated above is an installation of four 660 hp Southwest-Cooper Bessemer GMXD-10 Packaged Compressors, handling Industrial Gas' total line capacity of 100 MMCF/D.

Southwest Packaged Gas Compressors for main line compression are **being** installed for **less than $200 per horsepower.** And they will be running months before field assembled units can be built!

Lower first costs are only part of the story. Unattended operation, possible with the automatic controls and safety devices on Southwest Packaged Compressor Plants, cuts operating cost per horsepower-hour to a fraction of the cost of a fully attended installation.

The final economy for your pipeline is that this station never need be shut down completely. In South Louisiana, the capacity of a main line station with eight 660 hp Southwest units, is reduced only 12½ per cent when one unit is down. However, if two 2600 hp units were used instead, capacity would be reduced 50 per cent when one unit is down.

These are all proved facts. Southwest engineers can show you the **results** and savings pipelines are realizing now with Southwest Packaged Gas Compressors.

FOR GAS LIFT, GAS BOOSTER, PRESSURE MAINTENANCE AND SIMILAR PROJECTS.

SOUTHWEST INDUSTRIES, INC.

P. O. Box 19392, Houston 24, Texas

A $30,000 road to failure marks the way to Paul Cormier's new oil discovery that flowed a few weeks and then went dead. It is on the northeast flank of Orange field through a swampland area. ▸

◂ **Pumping 20 bbl a day** — 30 years ago, today, and perhaps tomorrow. Examining this living relic of Orange field are the author and Harry Whitley, superintendent for Texkan Oil Company. The well is Texkan's No. 1 McLean, which produces from the Miocene at 4200 ft.

total depth of 3230 ft. This original oil discovery was located three-quarters of a mile northwest of the present Orange field dome.

In 1920 the Little Six Oil Company completed the No. 1 Chesson at 1800 ft with a 50-bbl a day completion.

The fifth attempt of the Humble Oil Company to find oil at the dome proved fruitful on December 28, 1921, when the No. 5 Chesson was brought into production flowing 14,000 bbl a day from a deeper oil pay zone at 3900 ft.

At the time, this was the deepest well ever drilled in the Orange field dome area. Until the Humble discovery, cumulative oil production since the discovery date of 1913 was approximately 500,000 bbl.

From this point on Orange field production in the early twenties, the oil production spiraled upward and a one 12-months period shows a production of 5,000,000 bbl.

By the year 1929 over 27,000,000 bbl had been recovered from the Orange field dome.

During the following depression years activity was at a status quo until November 13, 1937, when the combine of Ryan, Thompson, and Tillery completed the No. 1 Chesson in the southwest part of the dome flowing 800 bbl a day.

The well was drilled through the Pliocene and Miocene series usually found on the dome. Above the oil zone was the typical Oligocene development, logged at the 5900-ft level. The well was drilled to 5946 ft with the last 15 ft being in the oil sand.

The new producing area was separated from the Orange field dome proper by faulting and was in a deeper horizon.

Geology

Orange field geologic structure has been described as a deepseated piercement-type salt dome. Oil production is from a central graben as a result of the block-faulting. The graben area has been interpreted as the Heterostegina deposited on the Vicksburg with the Marginulina and Frio absent.

Producing sands in the main receive a strong water drive with the structure being on the north-south axis. Three major faults with a northeast trend cut the major north-south elongation axis.

Productive formations are:

PLIOCENE —
- Lagarto: 1600-3200 ft (20-22 gravity oil)

MIOCENE —
- Oakville: 3274-4790 ft (21-23 gravity oil)
- Catahoula:
- Discorbis: 5200-30 ft
- Heterostegina: 5525-5600 ft (gas)
- Vicksburg: 5900-90 ft (35 gravity oil) 6100-20 ft

A typical drilling section would be:

RECENT-PLEISTOCENE —
- Beaumont-Lissie-Willis 0-1150 ft.

MIOCENE —
- Lagarto-Catahoula — 1150-5300 ft.
- Discorbis — 5300-5680 ft
- Heterostegina — 5680 ft

The salt has been topped at various levels at 7316 to 10,500 ft.

Productive acreage comprises about 1000 acres the field overlying a salt mass that has been topped at its shallowest point at 7316 ft and in another spot on the southwest part around 10,500 ft.

Although the field had been divided in the past into different discovery sections and reservoirs, the field is presently carried as one field under the Texas Railroad Commission oil proration schedule.

Mystery Well

Correlation between wells reveals a lensing in-and-out condition of the sand sections, but the multiple-pay possibility looms on every well with the added feature of a new zone. This was the case of the Al Brown No. 1 Hollis on the southeast part of the field.

The multiple-pay possibility is the real incentive for the continued drilling in the field today.

The Al Brown No. 1 Hollis has remained the mystery well of the field.

It was drilled and completed on February 7, 1952, in the Miocene section and perforations at 4204-4210 ft yielded 74 bbl a day with a tubing pressure of 750 psi with no water in evidence at that date or at the present writing. The production performance of this well is an exception for Orange field, but there is always that possibility of an operator finding another "mystery sand." The usual cycle of a new well is a flowing duration of a few weeks and then relegated to a pumping period with sand-control remedial work.

Several dry offsets have been drilled in an effort to tap this same Miocene sand logged in the Hollis well.

Paul Cormier, Orange field producer and drilling contractor, is gaging the Winfree tank battery. The Winfree opened new oil production on the northeast flank of the dome.

The Hollis well has recovered over 140,000 bbl of oil to date and is still flowing with a tubing pressure of 500 psi making its 72-bbl allowable daily.

Multi-Pay

Another example of the multiple-pay incentive is the success Charles and Lee Beck of the Beck Oil Company had on the north side of the field.

In May 1957, the Beck Oil Company No. 1 Craft was drilled to 7169 ft with the objective being the new gas-condensate sands discovered by Michel T. Halbouty on the W. L. Chandler acreage.

The lower Frio series at 7169 ft logging proved dry but up the hole at 3505 ft over 40 ft of new Miocene pay was logged. This was a new sand for this part of the dome and the well was completed at 3512-22 ft flowing 81 bbl a day through a 7/64-in. choke with a tubing pressure of 400 psi. This well flowed for several months and then remedial sand-control work was performed. A pumping unit has been installed and current daily production is between 20 to 30 bbl daily.

Prior to this discovery, Michel T. Halbouty of Houston completed the No. 1 W. L. Chandler as a dual completion gas-oil discovery which was drilled 1500 ft north of the nearest Orange field production. The salt was topped at 8937 ft.

The Halbouty No. 1 Chandler flowed 157 bbl of 36 deg oil from a sand at 6004-29 ft with a tubing pressure of 650 psi. Perforations at 7112-18 ft flowed 2,140,000 cu ft of gas with a gas-oil ratio of 33,000 to 1.

Orange Field Operators

In 1956 another new Miocene pay zone was uncovered with the completion of the W. V. Bowles No. 9 F. T. Peveto on the southeast side of the dome.

The Peveto well flowed 74 bbl of 24 deg oil through a ⅛-in. choke with a tubing pressure of 400 psi from perforations at 3772-77 ft. After a few months of flowing life the well was put on a pump and is now producing about 20 to 25 bbl per day.

The Bowles Company under the management of Pat Burton has been engaged in re-drilling old leases during the past 10 years.

Texkan Oil Company. The Texkan Oil Company, Richard M. Finder, president, came into the Orange field picture in 1954. By drilling old leases and purchasing existing production, it is now probably the biggest producer in the field with an allowable of 1154 bbl a day and monthly pipeline runs in excess of 28,000 bbl.

The Texkan company has met with success in controlling the encroachment of sand by a special process of "sand packing" worked out by M. D. Frazier, Texkan petroleum engineer, in conjunction with a service company that has since adopted the process. This sand control method prolonged the productive life of their pumping wells.

Paul Cormier. Paul Cormier, sole owner of the Paul Cormier Well Service Company, was in the casing salvage business soon after World War II and parlayed his salvage operations plus reworking old abandoned wells to the point where today he owns outright over 40 producing wells averaging 40 bbl of oil a day, all producing by pump.

Clifford L. Brown, Jr., Clifford L. Brown, Jr. of Corsicana likewise entered Orange field through the salvage route and after reworking old wells earmarked for abandonment soon began, with his father, the late C. L. Brown, Sr., building up the oil production.

The two Browns organized the Kilmarnock Oil Company, now operating over 40 oil wells having a production of 600 bbl daily.

Kadane-Brachman. The combine of Kadane and Brachman acquired the G. E. Glasco production and Lutcher-Moore lease on the north side of the Orange field dome.

The north part of the Lutcher-Moore lease offset the Beck Oil Company Miocene oil discovery and in turn proved at least five to eight good locations for the Kadane-Brachman holdings. This is in addition to the 23 currently producing oil wells.

Economics

The attraction of continued drilling in Orange field by present field operators has been attributed to: (1) Multiple producing sands, (2) relatively shallow drilling depths, (3) production is possible in practically all parts of the field, (4) new oil producing horizons are possible in any part of the field, but an operator must be prepared for some type of sand-control completion.

The mystery well of Orange field is Al Brown's No. 1 Hollis. Brown, right, shown here with author Cokinos, completed the 4200 ft Miocene sand well in 1952. Its pressure has remained almost constant and has consistently produced its 72-bbl per day allowable. All attempts at completing offsetting wells in the same zone, however, have failed.

Close Spacing

Close drilling has been the practice in Orange field since its discovery in 1913 and it has been indicated that because of the lensing of the Miocene producing sands, it has been necessary for closer density in drilling.

The Author

Geneos Pete Cokinos *is a senior petroleum engineer with the Oil and Gas Division of the Texas Railroad Commission and a petroleum engineering graduate of Texas A & M College, class of 1938.*

He is a member of the Society of Petroleum Engineers, American Association of Petroleum Geologists, and a registered Professional Engineer in the State of Texas.

Closed spaced wells are the rule rather than the exception. In one portion of the field, there is an average of one well for each two acres. This scene looks east at the Beck Oil Company Craft lease that opened new oil production on the north flank. A Miocene sand was logged at 3500 ft when the objective sand at 7200 ft shaled out.

In some parts of the field, wells have been — and continue to be — drilled on spacing of less than one well for every two acres. This is comparable to other Texas-Louisiana Gulf Coast salt dome fields.

Flank Possibilities

Regionally speaking, Orange field suggests flank possibilities if for no other reason but that its sister dome to the west, the Port Neches dome, has prolific flank production from the Lower Frio and Nodosaria on the northwest flank.

The production on the northwest flank of the Port Neches dome comes from deeper sands pinching out updip as the sands approach the domal uplift.

This has been placed in the stratigraph trap class and in the Texas Gulf Coast pinchouts are an important source of new oil sand findings. Gulf Coast pinchouts are seldom found through seismic operations and it remains for the subsurface work and isopachous maps to uncover the subsurface control.

It follows that if the formations around a dome are above regional normal, even though the formation may be water-bearing, there is still the possibility of oil and gas accumulation downdip — if the formations remain above the rim syncline and remain above regional normal.

This would be the case of the flanks of Orange field dome. There have been many tests during the last 10 years drilled around the flanks, but the old nemesis "salt water flow" has taken its toll. There is always present the spectre of a shale gas "kick" or a salt water flow at various spots on the Orange field dome as well.

Production Problems

The biggest production problem at Orange field is that of "sanding-up" around the perforations. Different methods of sand-control are being used in an attempt to answer the sand problem.

Salt water production is always prevalent since the primary source of reservoir energy in most cases is a strong water drive.

Usual completion practices in the field call for the use of scratchers, wipers, and centralizers.

Strong squeeze workover jobs are not recommended and squeezing of oil-water contacts are not made. If and when salt water does show in the oil production, the economic practice is to avoid squeezing as long as possible . . . then squeeze only as a last resort . . . and then it should be an easy-does-it type of squeeze.

New production of the flowing variety is not of a long period and the usual pattern is to install a pumping unit upon completion, and then face the inevitable and ever-menacing sand problems.

Everything Is Brown

The name "Brown" appears quite often on the Texas Railroad Commission oil proration schedule. There is in Orange field several land owner Browns and operator Browns.

On the landowner side is the H. L. Brown and E. W. Brown, Jr., interests, prominent Gulf Coast landowners and royalty holders.

There have been as many as four operator Browns in the field.

C. L. Brown, Sr. of Corsicana was the first into the field with his son Clifford L. Brown, Jr. who operates the Kilmarnock Oil Company and in his own name.

C. J. Brown of Houston moved into the picture during the forties with Al Brown of Tyler and Houston coming in later. To make it a complete Brown affair, the head gager in Orange field for the Gulf Oil Corporation is Dorsey Brown.

Pipeline

Orange field operators have the benefit of two crude oil pipelines operated by the Gulf Oil Corporation and by the Sun Pipeline. An outlet for marketing gas is the United Gas Pipe Line Company, only gas line in the field. The gas line also serves the drilling contractors using power rigs or steam rigs in the area.

Proration

The Texas Railroad Commission has an across the board of 72 bbl a day for any well completed in the field and shutdown days are exempt, however, the field's allowable is usually 20 to 40 percent underproduced from month to month.

Conclusion

It cannot be repeated too often that Orange field has proved that new oil sands can be found due to improvements in gamma ray and neutron logging methods with the result that virgin sands are being produced that would otherwise have been passed.

A "ratty" sand section on an electric log has proved with radiation logging interpretation and depth control perforating plus sand-control completion to yield oil that could have gone unnoticed.

Lifting cost figures have been averaged at $1.25 a bbl, but the multiple pay feature borne by radiation logging technique gives the operator several shots at a payout before salvage time comes around.

Acknowledgments

Old Orange field picture of fire is from picture files of Kid Williamson, Mauriceville, Texas.

Photos of scenes are by Harry Hess of Houston, Texas.

Production statistics and history are from files of Texas Railroad Commission, Houston, Texas. ★ ★ ★

EXPLORATION ACTIVITIES

IRAN

Pan Am Pays $25 Million Bonus for Persian Gulf Permit

The Iranian Parliament has ratified and the Shah has approved the recently concluded agreement between Pan American Petroleum Corporation, a wholly-owned subsidiary of Standard (Indiana), and National Iranian Oil Company for the exploration and development of a 16,000-square-kilometer (about 4,000,000 acres) offshore area in the northern part of the Persian Gulf.

Under this agreement Pan American Petroleum Corporation and National Iranian Oil Company will form and jointly finance a non-profit joint stock company, to be known as IPAC (Iran Pan American Oil Company), which will act as agent of the joint venture in exploration, development, and production of petroleum in the area of operations.

Pan American has agreed to spend $34,000,000 on exploration operations in the first four years and an additional $6,000,000 per year during the next eight years. Pan American may discontinue exploration without further obligation at the end of any year after the first four provided the obligation for exploration expenditures up to that time has been fulfilled. If a commercial discovery is made, Pan American may apply development expenditures against the total exploration obligation.

Exploration surveys will commence within six months and drilling of at least one exploratory well will start within 18 months. Development and operational expenses will be shared equally by Pan American and NIOC.

The exploitation period is 25 years from the date of commercial production, with provision for three extensions of five years each.

Within 30 days, Pan American will pay to the Iranian government a cash bonus of $25,000,000, which is about $6 per acre. In computing taxes due Iran, this bonus will be amortized over a 10-year period.

Both Pan American and NIOC will pay income taxes to the Iranian government equivalent to 50 percent of their net profits. There is provision for operating losses to be carried forward for 10 years.

No rentals will be paid during the first 12 years of the agreement. Thereafter rentals will be paid on a graduated scale, ranging from about $1.60 per acre in the 13th year up to about $2.50 per acre from the 24th year onward. Rentals are treated as a credit against Iranian income taxes.

GEORGIA

Another Attempt at Production Planned

GFA Oil and Gas Corporation of Moultrie, Georgia, has announced its intention of gaining a $250,000 bonus posted by the state legislature for finding first commercial oil in Georgia. GFA has staked its No. 4 Sealy, in Land Lot 24, Land District 21, four miles southwest of Donaldsville, in Seminole County. Well is scheduled to go to 8500 ft. The Survey Drilling Company of Dallas, Texas, is contractor. Surface hole is being drilled with cable tools prior to moving in rotary tools.

Four attempts were made to find oil in Georgia last year. These wildcats were in Marion, Pulaski, Seminole, and Ware counties.

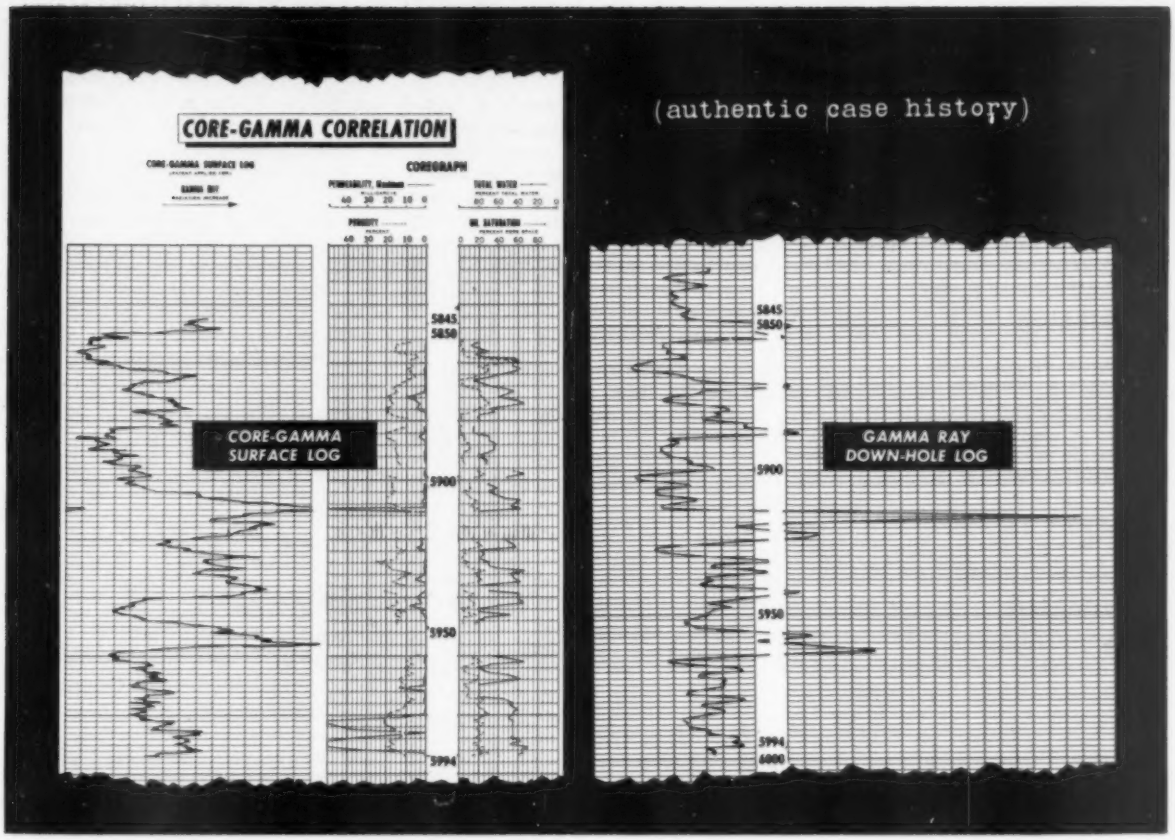
TUNISIA

Conorada Makes First U. S. Entry

An oil exploration permit covering some 11,000 sq miles in the west central part of Tunisia in North Africa has been granted Conorada Petroleum Corporation. Conorada is owned by Continental Oil Company, The Ohio Oil Company and Amerada Petroleum Corporation.

Under the terms, Conorada has agreed to spend $4,000,000 in the next five years in search of oil in west central Tunisia. Conorada is the first American oil company to enter Tunisia since it became independent last year. Only oil company now active in the country is a joint French-Tunisian concern. Concession territory is the historic area where British, American and French armies met during World War II to start the final drive to push the German and Italian forces from Africa.

Signing Conorada-Tunisian agreement are W. F. Penniman, Conorada vice president; Hedi Nouria, Tunisian Secretary of State for Finance, and Azedine Abassi, Tunisian Secretary of State for Commerce and Industry. Standing are Larram and Fourati, members of the Tunisian Government staff.



how to pinpoint a pay zone . . .

(Excerpts from informal field report)

"Glorietta Formation, Andrews County, Texas: Operator cored to 5942' and had us analyze samples. The lab results indicated some production . . . However, when compared to core analysis data on a nearby well it appeared doubtful that the desired pay section had been reached . . . We ran a Core-Gamma Surface Log and the operator compared it with down-hole gamma ray logs on adjacent wells . . . A good correlation indicated that another 52 feet should be cut, and the anticipated productive zone was found in the bottom 30 feet of this second core."

Unusual? Not at all! The Core Lab-developed method* of monitoring the gamma radioactivity of cores and comparing "surface" gamma ray logs with core analysis data and conventional gamma ray logs (from the same or adjacent wells) has opened up an entirely new concept of down-hole correlation.

The procedure is rapid, simple, and inexpensive. The applications are virtually limitless. Many operators are now requesting Core-Gamma Surface Logs on all core recovered.

Equipment for performing this new Core Lab service is installed in Midland, Lubbock, Pampa, Monahans, Hobbs, Farmington, Edmonton, Regina, and Calgary. Drop in and ask for a demonstration.

Core-Gamma Surface Log — another sign of leadership in the advancement of petroleum reservoir engineering.

*PATENTS APPLIED FOR

A sixteen-page brochure, describing the operation of Core-Gamma Surface Log equipment and outstanding case histories, is available for the asking. Address inquiry on your company letterhead to address below, attention Dept. S.D.

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DALLAS FT WORTH HOUSTON MIDLAND ABILENE SAN ANGELO PAMPA AMARILLO MONAHANS LUBBOCK HOBBS CORPUS CHRISTI VICTORIA MCALLEN SAN ANTONIO SHREVEPORT TYLER EL DORADO HATTIESBURG JACKSON TULSA OKLAHOMA CITY WICHITA FALLS BARTLESVILLE WICHITA LIBERAL LAFAYETTE NEW ORLEANS DENVER STERLING CRAIG CASPER WORLAND KIMBALL WILLISTON FARMINGTON LOS ANGELES BAKERSFIELD LONG BEACH CALGARY EDMONTON REGINA VENEZUELA S A

Exploration

TURKEY

Bolsa Chica Spuds
First Well in Series

Bolsa Chica Oil Corporation of Los Angeles, California, has begun drilling its first wildcat in Turkey. It is the No. 1 Zengilan, located on a block of 370,000 acres in the southeastern part of the country.

Bolsa Chica, who is operator of the project, is one-third owner. The test is to be the first of a series.

MONTANA

Amerada Spuds Deep
Geological Wildcat

Amerada Petroleum Corporation has begun drilling at another geological wildcat in the Outlook area of Sheridan County. Well is the No. 2 J. C. Tange, located in C SW NE, Section 20, 36n-53e. The well, in the Williston Basin, was staked several months ago. Surface casing was set about 1000 ft.

LOUISIANA

Block 28 Stepout Pays

A significant gas-distillate stepout has been completed by Kerr-McGee Oil Industries, Inc., in the Block 28 field, Ship Shoal area, off Terrebonne Parish.

The well is on State Lease 750 G-1, located 5554 ft from the west line and 5674 ft from the north line of Block 28, some 50 miles south of Morgan City.

Drilled to a total depth of 14,453 ft, the well after logging was found to have penetrated five commercial gas sands, with a total net pay of 240 ft. Net pay in the thickest sand was 124 ft.

Five-inch casing, run to the total depth, was perforated between 14,196 and 14,230 ft. The well flowed at the rate of 9 million cu ft of gas per day, plus 732 bbl of condensate, on a three-hour test through a 22/64-in. choke.

British-American Deep Well
Goes On Line

Intercoastal Shipyard No. 1, The British-American Oil Producing Company's deep discovery well in the Ramos field 10 miles southeast of Morgan City, in St. Mary Parish, went onstream May 8 with production at the rate of 3,600,000 cu ft of gas per day and 28 bbl of 52 deg API condensate per MMcf of gas. It is located in Section 46, T16s-R13e.

Total depth of the well is 15,125 ft. Alternately on 7/64 and 8/64-in. chokes, flowing tubing pressures was 9300 psi during the first day onstream. Well was completed through perforations at intervals between 14,672-761 ft.

NEW MEXICO

Union County Prospector
Extends Anadarko Play into State

Skelly Oil Company is attempting to find production in the extreme northeastern part of New Mexico to round out the new Anadarko Basin field that now includes southeastern Colorado, a portion of the Oklahoma and Texas Panhandle area and parts of southwestern Kansas.

The wildcat is Skelly's No. 1 Van Pelt, C N½ NW SW Section 9, 28n-35e, about 15 miles north of Clayton in Union County. Test is to the granite at 8500 ft. Well is to be drilled tight to the Mississippian, expected at about 4800 ft, reports indicate.

Also in this part of the state, Continental Oil Company is drilling an 8500 ft wildcat in Mora County. It is the No. 1 Mares-Duran, located in NE NW SW Section 14, 23n-17w.

OKLAHOMA

Republic Natural Gas
Completes First Morrow Test

Republic Natural Gas Company announces the completion of its Cities Service No. 9, a deep wildcat located in the SE SW Section 5, 4n-13e, Texas County. The well was completed in the Upper Morrow found at 6077 ft for a potential of 8½ million cu ft per day. The well encountered gas in the Council Grove at 3244 ft and tested oil at the rate of 25 bbl per hour in the Upper Cherokee found at 5499 ft.

This well is located on a block of 97,000 acres, 100 percent owned by Republic, presently producing from the Permian section.

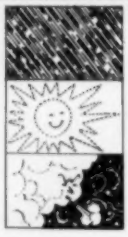
This is the first of a series of deep tests projected on the west portion of this block. A comparable well in the Morrow sand was completed on the east side in May 1955.

CALIFORNIA

Signal Starts
Drilling at Rancho

Signal Oil and Gas Company reported its second exploratory oil well in the West Los Angeles area at Rancho Golf Course. Signal is operator for itself and Richfield Oil Corporation on a 185-acre lease comprising the municipal golf course and the adjacent city-owned playground.

The well, Signal-Richfield Rancho No. 1, is being drilled on a site that has been excavated to aid in concealing the covered drilling tower. The Rancho drilling rig is electrically-powered and is sound proofed. A similar rig is being used currently for drilling at nearby Hillcrest Country Club, where Signal spudded in earlier this month.



ABC IS BUILT TO ROUGH IT!

There's a lifetime of luxurious living anywhere in an ABC Mobilehome. Every detail is as fine as long experience and skilled craftsmanship can make it. The 110 and 220V wiring and coded plumbing exceed any demand placed on them. The one piece body will not develop cracks or squeaks as you roll up the miles.

Look For These ABC Features: 1½" of hand packed insulation all around and 2" overhead. Radiant floor heat circulated evenly and economically throughout the coach. Full 7' ceilings, genuine hardwood interiors, nationally advertised appliances. Heavy gauge fire proof steel roof and bottom. Temperature controlled aluminum siding, dust proof doors and windows. ABC's cantilevered, welded steel tandem chassis is mounted on a standard width tread and heavy duty tires for safe towing anywhere. Your ABC dealer will make delivery anywhere in North America.

See your telephone directory or write to

ABC Coach Co. INC.

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36 Floor Plans
8' and 10' Widths
1 to 3 Bedrooms
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The MHCG Gold Seal is Your Guarantee of Honest Value

AT LAST!

COMPLETE UNDISTURBED CORE

where other means have failed

with the new

RUBBER-SLEEVE CORE BARREL*

This entirely new concept in core packaging delivers rubber-wrapped undisturbed core exactly as it was in the formation. The core is uncontaminated by drilling fluid, cannot crumble or bridge and is ideal for handling, analysis and transportation. The rubber sleeve barrel is particularly adaptable for coring in loose sands and shale and other unconsolidated formations where previous coring methods prove extremely difficult or impossible. For complete details on this revolutionary core packaging method write or call Christensen today and operate at "less cost per foot."

Cutaway diagram of rubber sleeve core barrel that delivers "packaged as cut" core.

The core is actually packaged by the rubber sleeve within the barrel delivering completely undisturbed core that can be handled without crumbling or other physical disturbance and is not altered by exposure.

CHRISTENSEN DIAMOND PRODUCTS

P. O. BOX 387 • SALT LAKE CITY, UTAH

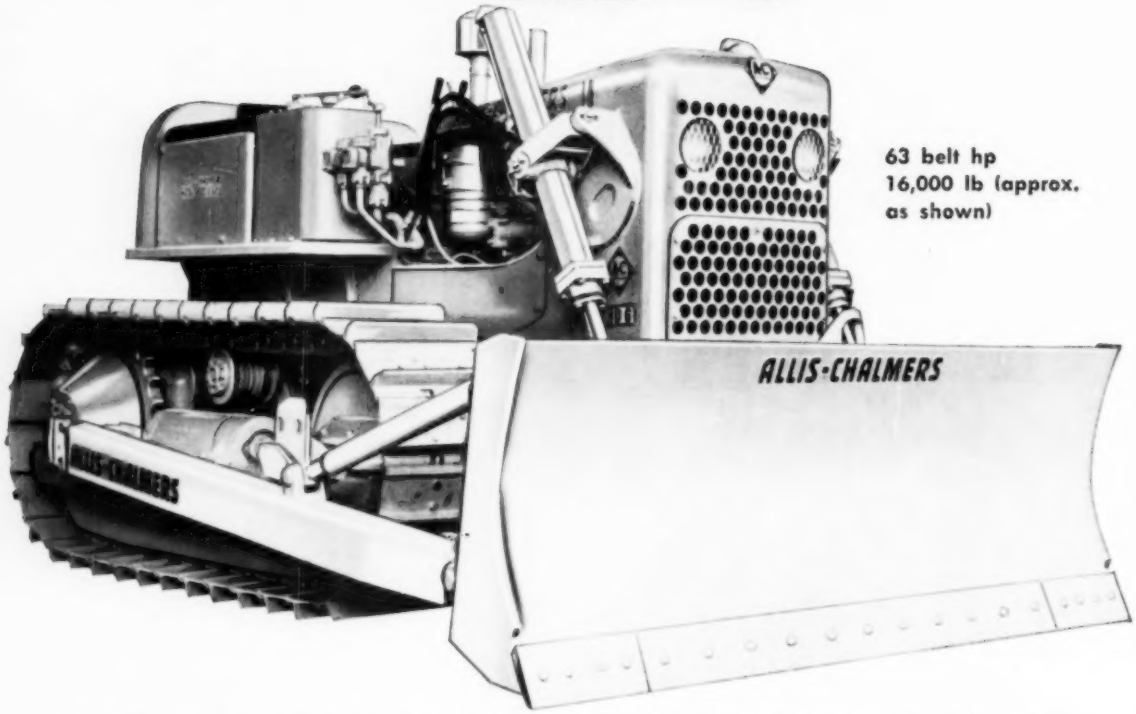
send for catalog SD608

**Manufactured only by Christensen Diamond Products Co. under exclusive license from Esso Research and Engineering Co.*

POWER for the job

PORTABLE without a permit

ALLIS-CHALMERS HD-6 Dozer



63 belt hp
16,000 lb (approx. as shown)

Oil field contractors find the Allis-Chalmers HD-6 measures up — both in performance and easy transport. It has the size, power and dependability to make money on oil field jobs — digging slush pits, building lease roads and fire walls, leveling drill sites, moving oil field equipment and supplies.

When traveling from job to job, there's no need to remove the dozer. The 8-ft blade — legal width for highway travel — lets you load your HD-6 right onto a truck or trailer — travel quickly with no time lost.

The HD-6 is a maintenance man's tractor. Even in the mud and corrosive brine of the oil fields, Allis-Chalmers Positive Seals protect tapered roller bearings on truck wheels, idlers and support rollers. These smooth-running assemblies require lubrication only once every 1,000 hours — change greasing time to profitable work time.

There are many reasons why more and more oil field contractors are using HD-6 dozer tractors. See your Allis-Chalmers dealer. He'll be glad to demonstrate on your job. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

Look ahead... *move ahead* ...and stay ahead with **ALLIS-CHALMERS**

Maps ??

Maps and Map Information On All Areas

ALLSTATE map makers
THE MAJESTIC BUILDING EDison 6-5803 FORT WORTH, TEXAS

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
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Water Flooding Gas Repressuring
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Cost Estimates, Design, Installation
FIELD SUPERVISION
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PANAMA

Texas American Acquires Promising Acreage

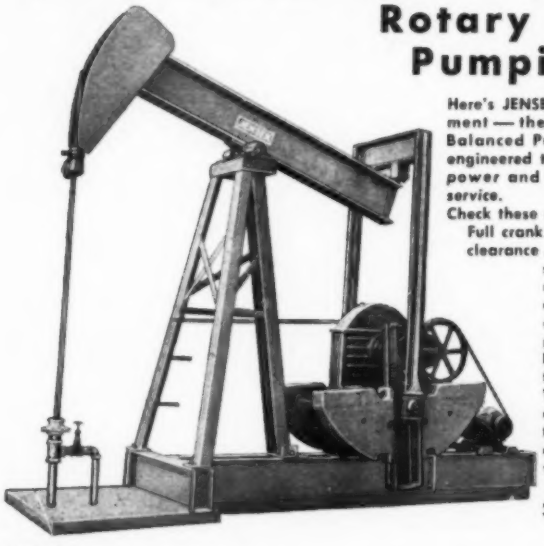
Texas American Oil Corporation and others have acquired a 80,068 net acre concession in the Republic of Panama. The concession directly offsets Champlin, Kerr-McGee, and Southland Royalty's property where a deep wildcat test well has just commenced drilling operations by these companies. Detailed geological and seismic work has been done by Champlin, et al and several large structural anomalies were mapped.

It is estimated that the structural basin in which Champlin's and Texas American's concession is located are underlain by some 16,000 ft of beds of Miocene, Oligocene, and Eocene age by approximately 2000 ft of Cretaceous limestone. All these formations are productive of oil and/or gas in various producing areas adjacent to the Gulf.

Texas American owns a net one-quarter interest and a one-quarter carried interest in the newly acquired concession. Texas American also recently acquired 27,000 net acres of overriding royalty and a 20 percent carried interest in an additional 134,000 acres of royalty adjacent to Champlin's concession.

NEW FROM JENSEN

Rotary Balanced Pumping Jack



Here's JENSEN'S latest oil field development — the all new line of Rotary Balanced Pumping Jacks — specially-engineered to give you *smoother lifting power and economical, trouble-free service.*

Check these outstanding features:

Full crank balance and complete floor clearance . . . larger and heavier main shafts and bearings...taller, more rigid Samson posts . . . easily adjusted counterbalance with extra weights . . . precision-cut single and double reduction gears...simplified lubrication system.

Write today for your copy of our catalog, fully describing the new JENSEN Rotary Balanced Line. A call or letter will bring it to you — quick!

STOCKED BY YOUR LOCAL DEALER

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Export Office: 250 Park Avenue, New York 17, N.Y.

JENSEN JACKS

B and W Inc.
A Good Combination for a GOOD CEMENT JOB

OTHER PRIMARY CEMENTING TOOLS: Hinged Nu-Coil Scratchers • Rotating Scratchers, Multi-Flex and Nu-Coil Types • Automatic Stop Collars • Stabilizers • Rotator Collars • Liner Centralizers.

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What's doing in DRILLING

Californians Color-Cue Country Club Rig

Signal Oil and Gas Company is going out of its way to please its Hillcrest Country Club neighbors at its drilling location on the club's facilities. Not only is the company completely soundproofing the rig used to drill its Signal-Richfield Community No. 1, but it is applying a few camouflage techniques. The derrick, which is completely covered, is painted nine different colors that subtly blend from sky-blue at the top to foliage-green at the bottom. Trees are being planted at selected locations on the club property to further conceal the tower from the view of the neighborhood. City ordinances require "safe and unobtrusive operation" on townlot drilling.

Brown Publishes 'Diggin' Dope'

Brown Drilling Company and its associated enterprises are issuing an attractive new publication called "Diggin' Dope." The employee newspaper-style publication is part of an all-out effort to weld company personnel closer together. In addition to being circulated to Brown employees in the U. S. and overseas, it will be used as a promotional venture by the company to explain the scope and nature of their operation to clients. "Diggin' Dope" is published in the firm's home offices in Long Beach, California.

Proposed Offshore Safety Laws Brings Industry Comment

Several bills are now pending in Congress amending the Longshoremen's and Harbor Worker's Compensation Act. These proposals may affect offshore drilling operations. Because of the different nature of stevedoring industry and the oil industry, industry leaders have been most interested in seeing that phase not be placed among the growing list of areas already governmentally controlled.

Appearing before a congressional committee hearing witnesses on proposed rule changes were AAODC President J. U. Teague and Humble Oil & Refining Company executive vice president Carl Reistle, Jr. Both pointed out that offshore oil workers did not need additional safety regulations, as reflected in comparative statistics. Reistle stated that injury rate in the petroleum industry was 9.32 disabling injuries per million manhours of work; disabling injury rate for the stevedoring industry was 88.5 per million manhours, quoting U. S. Department of Labor Statistics.

Teague stressed that the drilling industry had voluntarily met its safety needs and pointed out that, through its own programs had cut the injury frequency rate 25 percent during the past seven years.

Newly-Christened 'Julie Ann' Scores a Triple Completion

Dixilyn Drilling Corporation, operating from Odessa, Texas, reports that its new three-legged mobile offshore drilling platform "Julie Ann" drilled a well that has been completed as a triple producer, reportedly the second in the Gulf of Mexico. The well is located 12 miles off the coast near Leeville, Louisiana. Dixilyn drilled the well for Gulf Oil Corporation, completing it in zones at 10,275 ft, 10,550 ft and 11,300 ft. The "Julie Ann" is a $2,500,000 tripod-type mobile platform recently completed by R. G. LeTourneau in New Orleans.

Dale Mount Drilling Acquires Harry Bass' Tools

Drilling tools and assets of Harry Bass Drilling Company have been acquired by Dale Mount Drilling, Inc. Harry Bass has retired from the drilling contracting business to devote full time to his oil, gas, and other interests.

Involved in the transfer are five strings of tools rated at 7000 ft and deeper. Dale Mount Drilling, Inc., has been re-incorporated with Mount as president and R. D. Jocey as vice president. Offices of the new organization are in Dallas, with a West Texas office in Midland. The company's operations are in the Permian Basin and Mid-Continent areas of Texas, New Mexico, Oklahoma, and Kansas. All personnel of the former Harry Bass Drilling Company have been retained with the new organization.

50 Drilling Platforms For Lake Maracaibo

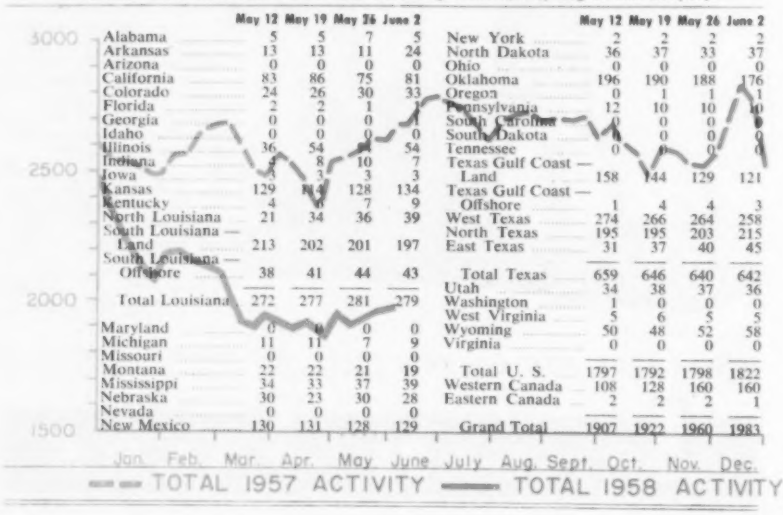
A contract has been awarded in the U. S. by Mene Grande Oil Company for the construction of 50 concrete deep-water drilling platforms in Venezuela's Lake Maracaibo. Work has begun, and completion of one platform a week is planned. These will be placed in 100 ft water. Mene Grande now maintains four active drilling strings in the deep section of the lake.

Contract for construction went to Raymond-Brown & Root, C. A. This firm has put 159 of the concrete structures in the lake in the past two years. The structures are made of long prestressed concrete cylinder piles. One style uses eight 36-in. piles and a second uses four 54-in. piles. Both include a precast concrete deck. All components are manufactured in Venezuela.

Rotary Rigs Operating in Oil Fields of United States and Canada

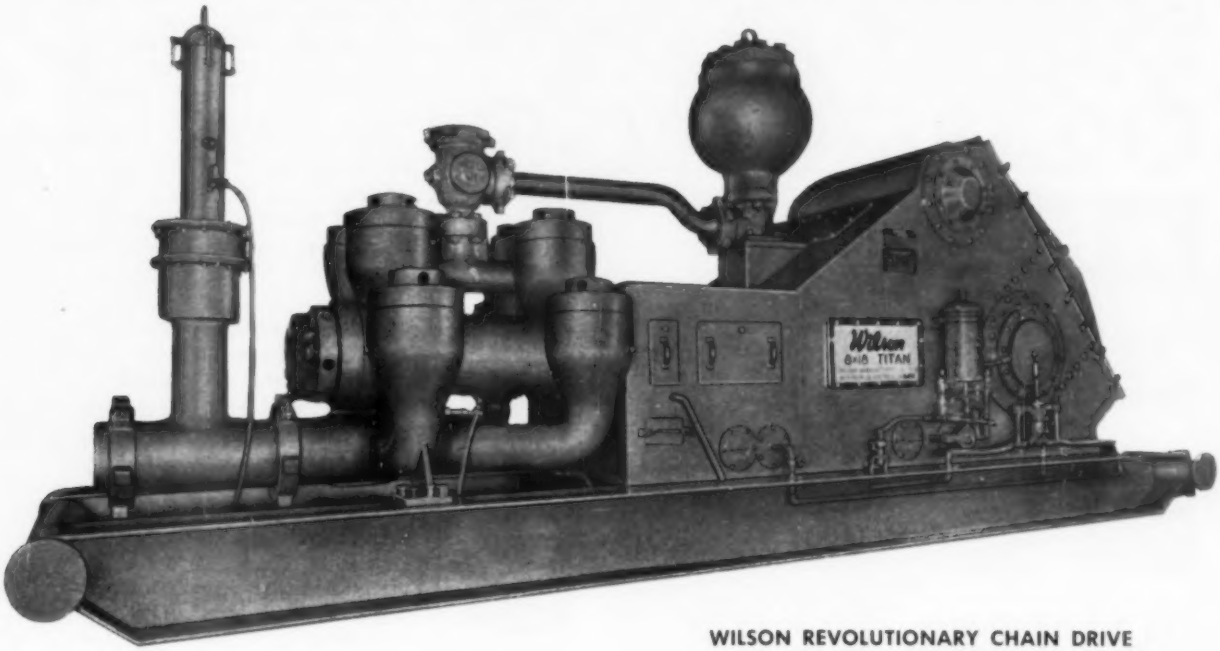
As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	May 12	May 19	May 26	June 2
Alabama	5	5	7	5
Arkansas	13	13	11	24
Arizona	0	0	0	0
California	83	86	75	81
Colorado	24	26	30	33
Florida	2	2	1	1
Georgia	0	0	0	1
Idaho	0	0	0	0
Illinois	36	54	54	54
Indiana	7	8	10	7
Iowa	3	3	3	3
Kansas	129	131	128	134
Kentucky	4	6	7	9
North Louisiana	21	34	36	39
South Louisiana — Land	213	202	201	197
South Louisiana — Offshore	38	41	44	43
Total Louisiana	272	277	281	279
Maryland	0	0	0	0
Michigan	11	11	7	9
Missouri	0	0	0	0
Montana	22	22	21	19
Mississippi	34	33	37	39
Nebraska	30	23	30	28
Nevada	0	0	0	0
New Mexico	130	131	128	129
New York	2	2	2	2
North Dakota	36	37	33	37
Ohio	0	0	0	0
Oklahoma	196	190	188	176
Oregon	0	1	1	1
Pennsylvania	12	10	10	10
South Carolina	0	0	0	0
South Dakota	0	0	0	0
Tennessee	0	0	0	0
Texas Gulf Coast — Land	158	144	129	121
Texas Gulf Coast — Offshore	1	4	4	3
West Texas	274	266	264	258
North Texas	195	195	203	215
East Texas	31	37	40	45
Total Texas	659	646	640	642
Utah	34	38	37	36
Washington	1	0	0	0
West Virginia	5	6	5	5
Wyoming	50	48	52	58
Virginia	0	0	0	0
Total U. S.	1797	1792	1798	1822
Western Canada	108	128	160	160
Eastern Canada	2	2	2	1
Grand Total	1907	1922	1960	1983

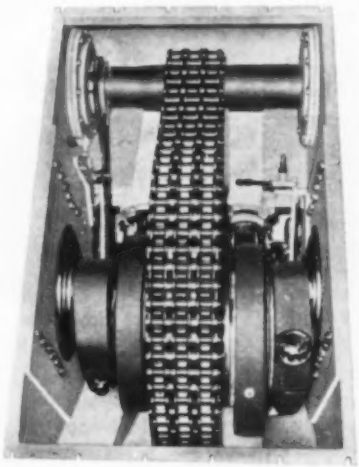


THE ANNOUNCEMENT THAT SURPRISED THE DRILLING INDUSTRY

The New 1250-Horsepower Wilson Titan Slush Pump



WILSON REVOLUTIONARY CHAIN DRIVE MEANS NO GEARS



Think of it! A 1250-H.P. pump that weighs ONLY 35,300 lbs. complete with pistons, rods, liners, valves, skids and Suction Flow Equalizer. Half the weight of a conventional pump! — 28 lbs. per horsepower! Far less initial cost per horsepower. Far less upkeep! Every modern feature: • Chain drive • Welded steel frame • Alloy steel mud end • Quickly removable valve covers • Quickly removable cylinder heads • Works efficiently from 600 to 1250 horsepower. Write for special bulletin.

• *So why buy an overweight, gear driven, expensive* **obsolete** *pump?*

BE MODERN - BUY WILSON

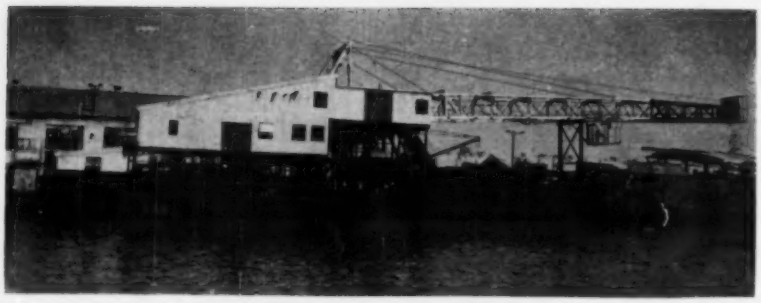
Wilson

WILSON MANUFACTURING CO., INC.
Wichita Falls, Texas, U.S.A. — The Home of Red Iron

Drilling

'Pocket Battleship' Added To Inshore Drilling Fleet

An advanced design drilling and workover barge is now in operation in South Louisiana for Work-Over Corporation. The 165 by 46 ft inshore barge, named the "Russell B," is designed to operate in depths up to 13 ft. Derrick floor is 22 ft above the barge deck; the high substructure permits use of maximum blowout preventer equipment.



Pumping equipment aboard the "Russell B" includes a triplex plunger pump and a 7 by 14-in. duplex, either powered by a 390 hp diesel. Also included is a 16-in. stroke, 625 hp mud pump and an 18-in. stroke auxiliary pump. Raising and lowering of the drilling barge is accomplished by use of the mud pumps.

Main drive for pumps and drawworks are three diesel engines which can deliver up to 1170 hp. The unit has a heavy-weight 134-ft jackknife mast.

Work-Over Corporation, with main offices in Houston, Texas, has branches in New Orleans and Jennings, Louisiana, has conducted drilling operations in the South Louisiana area for almost 20 years.

ROCKFORD

OIL FIELD TYPE

LONG LIFE
Heavy-Duty

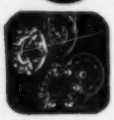
POWER TAKE-OFF
Eliminates the Pilot Bearing

- Eliminates the Pilot Bearing
- Release and Main Bearings are lubricated for one year
- Main Bearings are 40,000 hour type
- Handles 5,000 pound Belt Loads
- Out-Board Bearings and Flexible Couplings eliminated
- Furnished with Single or Double Plate, Organic or Morlife* faced Gear tooth Type Clutches

Insure longer work life and reduce down-time with this NEW extra heavy-duty ROCKFORD POWER TAKE-OFF.

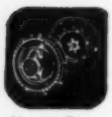
BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
1303 Eighteenth Ave., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.


Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc


Heavy Duty Over Center

Power Take-Offs

Speed Reducers

CLUTCHES

PROGRESS REPORT NO. 4 Anadarko Basin No. 1 Caddo County, Oklahoma

During the 31 days prior to June 10, Howell & Howell's Anadarko Basin No. 1 drilled from 15,486 ft to 16,625 ft, completing 212 days of drilling in Oklahoma. Penetration rate for the period averaged 36.7 ft per day, declining from 47.8 ft per day drilled during the previous like period. Drilling was slowed by hard sands during most of the month.

Since setting 13⅜-in. casing to 7903 ft, drilling has progressed in 12-in. hole through several gas zones. Considerable volumes of gas have been produced and are being handled at the surface. However, the gas may lead to running the next string of casing — 9⅝-in. — before reaching the original target depth of 19,000 ft for the string.

Howell & Howell is drilling the hole with a tapered drill string consisting of lengths of 4½-in., 5-in., and 5½-in. pipe. Double elevators are being used to handle the string. Round-trip time at present depth is from 11½ to 12 hours.

Mud weight has been increased slightly to 12.3 lb per gal, with oil content being held at approximately 11 percent. Viscosity is around 55 seconds. As of June 10, drilling was in shale with bit No. 146 in the hole.

This well is planned to drill to 24,000 ft, but engineering has been completed to 25,000 ft. (*The Petroleum Engineer*, March 1958, page B-31.)

Rimrock Tools Up for International Operations

Rimrock International Company (Rimco) has been formed in Shreveport, Louisiana, to engage in worldwide contract drilling and exploration operations. W. O. White, formerly vice president of Rimrock Tidelands, Inc., is president and director of the new company. Rimco has acquired four rigs located in the Gulf Coast area, and one rig in the European Mediterranean area for use in its operations. The company has acquired, or has negotiated for, permits covering 8,655,715 acres in France, Switzerland, Paraguay, Sicily, Tunisia, and Turkey.

Several subsidiary companies are now in operation. Rimco's Swiss company, Mofag Oil Exploration Company, Ltd., will drill this year in the Aquitaine Basin in France. It will be located on a site near La Tour Blanche, 85 miles northeast of Bordeaux. Rimco will utilize its rig now in the Mediterranean area.

Another subsidiary, Societa Oli Minerali, has acquired new permits in Tunisia. This firm operates from Sicily. It is agreed to acquire a company with exploration permits in Turkey.

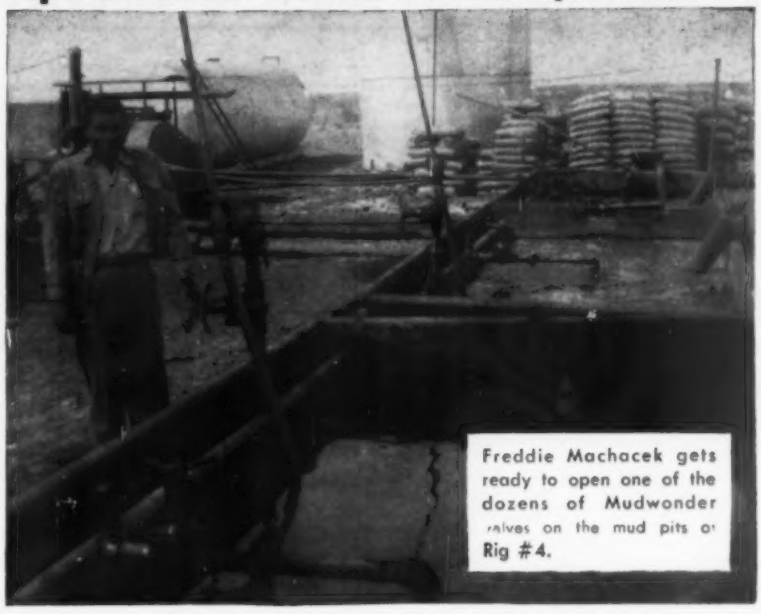
Trinidad Drilling Activity High

Drilling in this Caribbean island resort is continually increasing. Nearly 30 rigs now active, including rigs operated by four contractors. Interest in offshore areas is high. Dominion, Ltd., brought in the former California deep water drilling ship, CUSS I for exploring in water nearly 200 ft deep. A German-made offshore drilling barge of the DeLong type will shortly be put into service in the offshore waters of Trinidad. The Texas Company is now principal lease holder in the area, and plans big directional drilling program from 128 by 36-ft concrete caisson platform to accommodate 36 wells.

Germans Use Russ Turbodrills

Manufacture of Russian design turbodrills has begun in Germany by two oilfield equipment plants. The two companies have licenses validated for 41 countries. The Soviets put some 30 turbodrills into operation by various oil producing companies in February. These range in size from 5 to 9-in. OD, and for the most part have been used after the hole has been drilled to 4000 to 5000 ft with conventional rotary tools. First of the German-made turbodrills are said to be in use now. A group of Russian engineers and drillers came to Germany recently to assist German drilling engineers in the operation of the turbine devices.

Tips on Mud Valves for Toolpushers . .



Freddie Machacek gets ready to open one of the dozens of Mudwonder valves on the mud pits of Rig #4.

MUDWONDER Ideal for Versatile Service

by Freddie Machacek, Toolpusher, Rig #4
B.B.M. Drilling Company, Midland, Texas

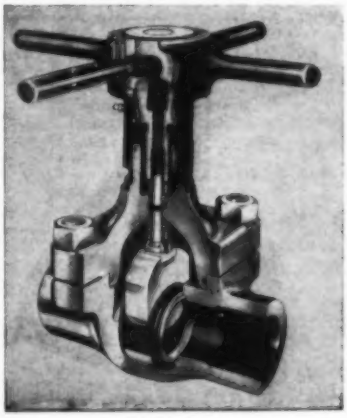
ABOUT two years ago I put a *Mudwonder* valve on our fill-up line just to see how it would make out. I soon found that *Mudwonder* worked fast and easily, without binding, even while bleeding off the line at 1600 lbs pressure. It did so well I tried more *Mudwonders* on the tough job of mud pit service—and they were so successful I've standardized on *Mudwonder* ever since!

Valves on mud guns and jets take a terrific beating, but we've had very little trouble with *Mudwonders*. As a matter of fact, our first ones are still in service; we replaced the stem packing on one valve—that's all! Because replacement parts are so easy to identify, we never have any trouble getting the exact part we need. In fact, the valves are designed to use the same seat and gate for both pressure classes.

When we have to dress a *Mudwonder*, the job can be done without disturbing any connections. The valve is out of service only about 10 minutes, start to finish, regardless of size. Another thing—they never sand up. Bob Lawrence, Edward *Mudwonder* Representative, says this is because the design causes the mud to flush the bonnet automatically.

Mudwonder valves are available in 2", 3" and 4" sizes; with screwed or flanged ends; rated at 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test). See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

Mudwonder cut-away view shows the one-piece seat insert, with Buna-N molded integrally over steel wear rings; chromed gate with "T" slot connection; separated stainless stem and double thread construction.



RUNNING TOUR with MEN in the INDUSTRY

▸ **Harry A. Trueblood Jr.** has been elected president and chairman of the board of Consolidated Oil & Gas, Inc. Trueblood

H. A. Trueblood Jr.

S. A. Levine

formerly was president of Colorado Western Exploration, Inc. **Saul A. Levine** was elected secretary-treasurer of Consolidated. He formerly served in the same capacity for both Colorado Western Exploration, Inc. and Consolidated Rimrock Oil Corporation, which companies recently merged to form Consolidated Oil & Gas.

▸ **P. A. Gass** has been appointed to the position of a senior vice president of Northern Natural Gas Company. He was formerly vice president in charge of personnel.

▸ **Dr. J. Donald Ryan,** associate professor of geology at Lehigh University, has been elected president of the Eastern section of the Association of Geology Teachers. He succeeds **Dr. Erling Dorf,** professor of geology at Princeton University.

▸ **John F. Lynch,** president of La Gloria Oil and Gas Company, has been elected a director of Texas Eastern Transmission Corporation. All other members of the board were re-elected. He has been associated with La Gloria Oil and Gas Company since 1944 and has served as president since 1947.

▸ **J. B. Oakley,** formerly assistant division engineer at Pan American Petroleum Corporation's Canadian division office in Calgary, has been named district engineer at the firm's Alberta district. **H. W. Hinkle,** formerly district engineer at the Alberta district, has been appointed field superintendent at the Pan American Pembina area. **W. M. Bogert,** formerly field superintendent at the Pembina area, has been transferred to the Edmonton area, where he will be field superintendent.

▸ **William P. Allen,** chief scout for Imperial Oil Company, Ltd. of Calgary, Alberta, Canada, has been elected president of the National Oil Scouts and Landmen's Association.

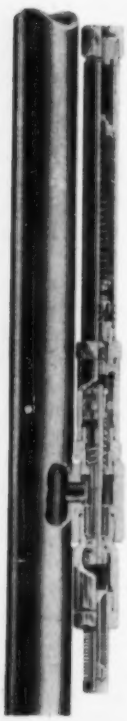
Newly elected officers are: Seated (l-r) **George Hogan** (LaGloria Oil), Corpus Christi, Texas, editor-in-chief; **W. F. Taylor** (Superior Oil),New Orleans, Louisiana, 3rd vice president; **Leland Abel** (Magnolia Petroleum), Wichita Falls, Texas, secretary-treasurer; **Ernest Allerkamp** (Standard Oil of Texas), San Antonio, Texas, 2nd vice president; **Mal Kidwell** (Shell Oil), Abilene, Texas, 1st vice president, and Allen, president.

Present officers, who will retire in January, are: (left to right) **George B. Ross** (Humble), Midland, Texas, editor-in-chief; **Charles Kelly** (Sun), Bismarck, North Dakota, 3rd vice president; **Daniel Greene** (Magnolia), Mt. Vernon, Illinois, secretary-treasurer; **J. B. Johnson** (Sohio), Oklahoma City, Oklahoma, 2nd vice president; **Walter B. Holley** (Lion-Monsanto), Houston, Texas, 1st vice president; **George D. Echols** (Standard Oil of Texas), Tyler, Texas, president.

Elections were held at the association's 35th annual meeting.

Attention: Gas Lift Operators –

USE THE BEST!!!



Type "WF-3" INTERMITTING GAS LIFT VALVE

- Only intermitting gas lift valve that will consistently operate on choke control of surface injection gas. (See footnote.) Can also be controlled by time cycle or pressure reducing regulator.
- Valve strings can be designed with all valves set at same operating pressures or each valve set at increased operating pressure with highest pressured valve in bottom of the string. (See footnote.)
- Not a pressure charged bellows valve — pilot controlled with predetermined operating pressure controlled by compression of an accurately designed and constructed spring.
- Operating pressures unaffected by well temperatures — ideal for operating two strings valves in dually completed wells with same annulus operating pressure.
- Valve spread controlled by pilot valve and pilot valve seat, same size ½" diameter main port in all valves.
- Snap-opening, snap-closing, non-throttling. All metal parts manufactured from nickel alloys.

Footnote: Methods covered by U. S. Patent No. 2,642,811

For details contact your nearest Merla Distributor or write for gas lift valve equipment folder No. 657 and Gas Lift Practices and Principles Manual No. 457.

MERLA TOOL CORPORATION

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Dallas 21, Texas

A. B. (Boone) Macaulay, Atlantic Refining Company, has been appointed manager of the Oklahoma-Kansas region of

A. B. McCaulay

T. C. Frick

F. W. Turner

the firm's domestic crude oil production department. He has been serving as assistant to the vice president and general manager of domestic and foreign production. **O. C. Clifford** Jr., has been appointed manager of the foreign crude oil exploration division. He was formerly chief geophysicist for the company's domestic exploration division. **Thomas C. Frick** has been appointed regional manager of Atlantic's Louisiana region. He has been serving as manager of the company's domestic production division. Succeeding Frick will be **Forrest W. Turner,** who presently holds the position of regional operations manager in the Dallas-eastern region.

R. J. Dobson, Houston area production superintendent, has been named exploration and production manager at Pladju, Southern Sumatra, for Shell Oil Company.

Thomas O. Allen, senior supervising petroleum engineer with Humble Oil & Refining Company, will leave that company to become manager of drilling and development division of Jersey Production Research Company in Tulsa.

Marvin L. Brown, Sun Oil Company veteran of 39 years, has retired. He was division operating superintendent of Sun's Michigan production division.

Donald J. Tucker has been appointed treasurer for the Brown Drilling Company, Long Beach, Calif. Tucker replaces **Dave Smith,** recently transferred to the position of material coordinator and office manager for Brown International Drilling Company, in Turkey.

Robert C. Sharp was named to take full charge of all overseas operations for

D. J. Tucker

R. C. Sharp

the International Brown Drilling and will also be a vice president. He served with the Drilling & Exploration Company of Delaware, Inc., for 13 years before taking his new post with Brown.

Eugene M. Locke, Dallas lawyer and director of Magna Oil Corp. and Dallas Tank Co., was elected president of Texas Independent Producers and Royalty Owners Association at TIPRO's annual membership meeting held in San Antonio in May. Raymond D. Reynolds, Houston geologist and independent producer, is the new secretary.

William N. Cones has resigned as vice president of American Petrofina Company of Texas, Dallas, Texas. He plans to engage in the oil and gas business as an independent with offices in Corpus Christi.

R. L. Higginbottom has been appointed superintendent in charge of Cities Service Oil Company's Oklahoma City and Seminole production districts. He was formerly district superintendent at Madison, Kansas. **L. D. Todd Jr.,** production foreman in the company's East Kansas district, has been promoted to district superintendent at Madison.

E. W. Peterman has been named superintendent of the Wichita, Kansas, production district. He was previously assistant district superintendent at Oil Hill Kansas. **Jim Hutchinson,** district engineer at Cheney, Kansas, will transfer to Wichita, serving as engineer for that district.

Franco Western Oil Company has opened a district office in Farmington, New Mexico. The exploratory program will be under the direction of **R. L. Knight,** district geologist. He was formerly with the Shell Oil Company as stratigrapher and geologist.

Lee K. Worth, assistant to the vice president of production, Pan American Petroleum Corporation, has retired from the firm after nearly 39 years in the oil business.

Harold T. Byck has been named assistant to the vice president of Shell Development Company's exploration and production research division in Houston, Texas. He has been technical assistant to the president of Shell Development Company in New York since 1953.

Dave Goodwill has assumed the position of district superintendent, Summerland district, producing department, of Standard Oil Company of California. In the new position he will be in charge of offshore operations at Summerland for the Standard of California-Humble Oil & Refining Company joint venture.

Harry C. Jones of Carter-Jones Drilling Company, Kilgore, Texas, was honored with a service recognition award for serving as membership chairman of Texas Independent Producers and Royalty Owners Association.

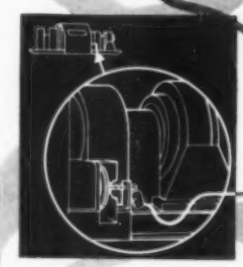
Dr. William Schriever, University of Oklahoma physics professor, has been awarded the first honorary membership in the Geophysical Society of Tulsa.

Herbert L. Peel, general production superintendent, The Vickers Petroleum Company, Inc., Wichita, Kansas, has resigned to accept a similar position with Cheyenne Oil Corp., Wichita Falls, Texas.

W. Harry Mayne, Petty Geological Engineering Company, has been elected president of the Geophysical Society of South Texas. Other officers are **J. W. E. Edmonson,** associated with the consulting firm of P. E. Narvarte, vice president; and **P. J. Rudolph,** Petty Geophysical Engineering Company, secretary-treasurer. The Executive Committee is composed of Mayne, Edmonson, Rudolph, **W. Lee Moore,** Petty Geophysical, and **Wm. R. Gray,** consulting geologist.

MARTIN DECKER

Rotary Tachometer



Increase Penetration

Drilling rate is a function of rotary speed. There is an optimum speed for each depth and formation. The driller must know rotary speed at all times so he can return to the optimum speed after each connection and make accurate reports.

Save Equipment

Tool joints and rotary equipment are powered by more horsepower each year. They are designed for rugged use, but an instrument is needed to protect this investment against abusive use.

The New Electric Tachometer

The new Martin-Decker Electric Tachometer is self energized. It is easily installed and calibrated to any rig. The new electric model has no mechanical tachometer cable which requires periodic replacement. The signal can be recorded on the new Martin-Decker electric recorders. This instrument is a rugged, dependable tool designed for years of active use.

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Versatile Emergency Jack Lifts 15 Tons at 4 Lifting Points

Lifting, skidding and leveling rigs; pushing, pulling and positioning machinery; supporting pipe and equipment are just a few of the oil field jobs done easily with the versatile Simplex No. 310A Emergency Jack. It handles full 15-ton capacity at four points; has 13" lift with minimum toe height of 2¼"; tilts on base for use at any angle.

Unique "Center-Hole" Hydraulic Units Pull . . . Lift . . . or Push in Any Direction

Pulling or installing cylinder liners, valve seats, pinions, bushings, wrist pins, keys, wheels, gears, etc. is fast and easy with a Simplex "Center Hole" Hydraulic Unit. Also serves as heavy-duty jack or hydraulic press. Remote-controlled and self-contained models in 10 to 100 tons capacity. "Center-Hole" tubular construction simplifies rigging, eliminates torque, makes pulling easier.

OTHER SIMPLEX OIL FIELD JACKS . . . include Lever, Screw and Standard Hydraulic types in a complete range of sizes and capacities.

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Miniature Jack for 50c!

This 3" high Simplex Screw Jack will lift 500 pounds two inches. Has all operating and construction features of larger screw jacks. Also is ideal desk ornament, paper weight. 50c ea. Shipped prepaid. Send cash or check to:

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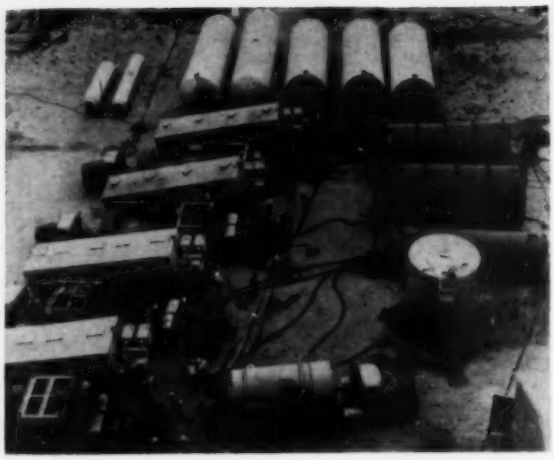

Cementing equipment assembled and in use during record cementing job at world's deepest well, Phillips Petroleum Company's I-EE University.

Cementing Job Sets Record At World's Deepest Hole

THE WORLD'S DEEPEST WELL, Phillips Petroleum Company's wildcat test in Pecos County, West Texas, made drilling history last month when casing was run to 22,919 ft. A combination string of 7 and 7⅝-in. casing was run and set for the record job on the 1-EE University. In spite of a whipstock at nearly 20,000 ft and almost 12,000 ft of open hole, the pipe was landed and cemented without incident in little over 29 hours.

Equipment assembled for the cementing assignment by Halliburton Oil Well Cementing Company included 4 lo-boy cementing units, each mounting two T-10 pumps; four 1200-cu ft field storage bins; two 500-bbl mud tanks and one 250-bbl mud tank; one bulk cement truck; and a standby cementing truck that was not used. Phillips supplied four 250-bbl water tanks for mixing. The mixing process required 760 bbl of water.

Cementing material consisted of 1147 sacks of slow-setting cement; 42,127 lb (40 percent by weight of the cement) of a low density additive; 1617 lb (1.5 percent by weight of the cement) of a low water loss and retarder additive; and 100 sacks of slow-setting cement with 141 lb of retarder additive to tail-in the lower portion of the casing and the shoe. An excess of 10 percent cement was run over the calculated amount. Static bottom-hole temperature was 315 F.

Minimum pumping rate was set at 6 bbl per min. Pump pressure settled to 1500 psi after pumping was established. All cement was mixed and in the casing after an hour and 54 min from the start of the job.

A 7⅝-in., 5-wiper top cementing plug was released to follow the cement which was displaced with mud until the plug was bumped. Total displacement was 951 bbl with pressures ranging around 1600 psi during most of the job.

A total of 5183 cu ft of cement slurry was displaced during the job. The cement was mixed at 10.8 lb per gal and was tailed-in with a 16.0 lb per gal slurry. A temperature survey following the job indicated the top of the cement was 4100 ft from the surface — the world's longest cement column ever placed.

(For additional data on this well see page B-21)

POWELL

world's largest family of valves

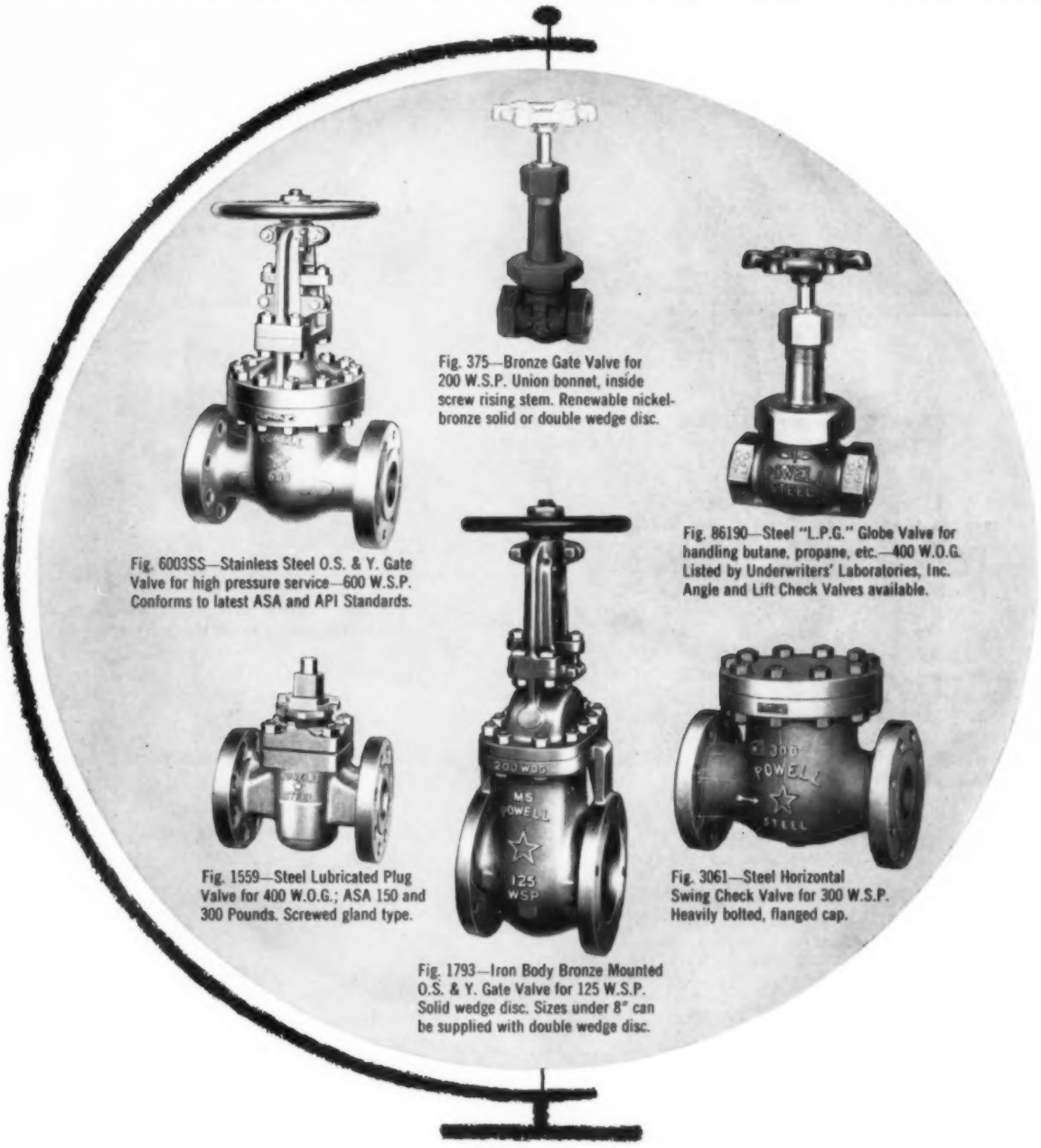

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 6003SS—Stainless Steel O.S. & Y. Gate Valve for high pressure service—600 W.S.P. Conforms to latest ASA and API Standards.

Fig. 86190—Steel "L.P.G." Globe Valve for handling butane, propane, etc.—400 W.O.G. Listed by Underwriters' Laboratories, Inc. Angle and Lift Check Valves available.

Fig. 1559—Steel Lubricated Plug Valve for 400 W.O.G.; ASA 150 and 300 Pounds. Screwed gland type.

Fig. 1793—Iron Body Bronze Mounted O.S. & Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061—Steel Horizontal Swing Check Valve for 300 W.S.P. Heavily bolted, flanged cap.

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

higher octane levels and longer catalyst life...with existing equipment

If you have the problem of increasing octane rating and production, investigate Sinclair-Baker RD 150! You can do it with your existing equipment, merely by replacing with Sinclair-Baker RD 150 Platinum Catalyst. Its efficiency in producing important yield increases at high octane levels is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst . . . further, it is regenerative in situ! Costs are sharply reduced to lowest level. A representative will be glad to give you detailed information upon request. All data of confidential nature are of course treated accordingly. Literature is available.

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for detection, measurement of oxygen or hydrogen impurities in other gases

This SUPER SENSITIVE DE-OXO INDICATOR continuously measures oxygen or hydrogen present as impurities in other gases. Accurately indicates from 0.0002% to 0.0200% (2 to 200 parts per million) oxygen and from 0.0004% to 0.0400% hydrogen. A dual range permits measurement of up to 0.25% oxygen or 0.5% hydrogen.

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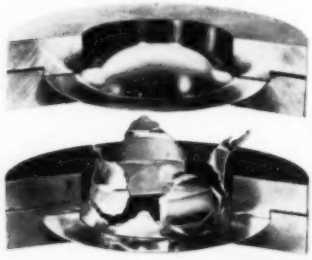

instant automatic release of excess pressure

Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ± 5% of specified pressure.

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BAKER PLATINUM DIVISION

New Projects in refining gas processing petrochemicals

Devon-Palmer Oils Ltd. and Texas Gulf Sulphur Company, Inc. began work on their huge $8-million sulfur recovery project last month, at Calgary, Alberta. Approximately 10 miles of gathering system pipe was delivered. Ten-inch pipe will be used to connect six gas wells into a system to supply a $6 million sulfur plant with 30 MMcf per day of raw gas. Actual work on the plant also began last month. The Okotoks gas to be processed contains about 34 percent sulfur, one of the highest reported in Canada. The plant, when on full stream by mid-1959, processing 30 MMcf per day will yield 12 MMcf of saleable residue gas, and 370 long tons of sulfur per day. On a yearly basis, saleable poducts from the Okotoks plant will amount to approximately 4.25 billion cu ft of "sweet" gas and 126,000 long tons of sulfur. Total reserves in this are more than ample to supply the sulfur recovery plant for 35 to 40 years. Present wells in the area said to be sufficient to meet plant requirements for 11½ years. Both Devon-Palmer and Texas Gulf will initially each receive at least 42½ percent of the plant's production. Texas Gulf Sulphur Company will handle marketing of a major-portion — and possibly all — of the sulfur.

Waskom Natural Gas Corporation will triple the throughput of their Waskom natural plant in Harrison County, Texas, when they install a Sinclair-Baker catalytic reforming unit and paraffin removal unit. The plant has a present daily capacity of 50,000 MMcf. Chem-Gas Engineers, Inc., Houston, is designing the units.

Goodrich-Gulf Chemicals, Inc. is constructing additional facilities at its Port Neches, Texas, plant for manufacture of carbon black master batch rubbers. Facilities will cost in excess of $1-million and are designed to produce a new type of dry man-made rubber containing carbon black. Construction started in June with completion scheduled for late 1958. The Catalytic Construction Company is doing the engineering-construction work.

Socony Mobil Oil Company de Venezuela's new refinery will be built by the M. W. Kellogg Company and its subsidiary, Compania Kellogg de Venezuela, Caracas. Facilities will consist of a 40,000 bbl per calendar day single stage atmospheric distillation unit, including gasoline fractionation and stabilization; a 6000 bbl per calendar day catalytic reforming unit and a caustic treating unit. The refinery is expected to go onstream in late 1959.

Magnolia Petroleum Company will build a 150 MMcf per day gas processing plant at Cameron Meadows, in southern Louisiana. Scheduled for completion in April 1959, plant will include an ammonia absorption refrigeration unit to provide 1200 tons of cooling capacity.

Cabot Carbon Company will start construction on a $1 million natural-gasoline plant scheduled for completion late this year. The plant will be located near Glenrock, Wyoming, will have a capacity of 8 MMcf per day.

Stanvac plans second Australian refinery. Standard-Vacuum Oil Company will build a second refinery in Australia on a 500-acre site at St. Vincent Gulf, 20 miles south of Adelaide.

The company says preliminary engineering plans are under way. A crude capacity of 35,000 barrels a day is planned.

Japan's first synthetic rubber plant has been contracted for construction to Blaw-Knox Company and will be located at Yokkaichi, Japan. The plant will cost $30-million, will have an annual capacity of 45,000 long tons of GR-S rubber. Blaw-Knox is also placing into operation Great Britain's first GR-S synthetic rubber plant, at Fawley.

The Carter Oil Company has begun work on a new hydrofluoric acid alkylation unit at its Billings, Montana, refinery. This unit is the second phase of a $2.4-million expansion and improvement program. Contract for construction of the new unit has been awarded to the Refinery Engineering Company of Tulsa, with completion scheduled for early spring, 1959. First phase of the program increased refinery capacity 36 percent.

Liquid oxygen and nitrogen plant to be built at Pittsburg, California. Linde Company, Division of Union Carbide Corporation, will build a 300 ton-a-day producing plant in California. The plant will have a total monthly capacity of more than 220 million cu ft of oxygen and nitrogen.

Standard Oil Company of California, Western Operations, Inc., announced plans to expand its refinery at Richmond, California. A 40,000 bbl per day fluid catalytic cracker will be installed to increase production of motor gasolines. Construction will start immediately and is scheduled for completion during the summer of 1959.

Work on BP Canada Ltd.'s new refinery in Ville D'Anjou, on the island of Montreal, has started. Capacity will be 25,000 bby per day; initial operations are scheduled for mid-1960. Lummus Company of Canada Ltd., is the overall contractor.

Para-xylene manufacturing plant to be built in Japan. Scientific Design Company, Inc. has been awarded a contract to design a para-xylene plant for Mitsui Petrochemical Industries, Ltd. of Tokyo, Japan. Atlantic Refining Company and Standard Oil Company (Indiana) have licensed two processes to Mitsui Industries. Standard's separation process will be used to extract high purity para-xylene from mixed xylene feedstock while Atlantic's new "Octafining" process will convert isomers of para-xylene to para-xylene. Plant will be constructed at Iwakuni City, Japan, and is scheduled for completion in the summer of 1959.

BP Canada Ltd.'s new catalytic reformer at the Kwinana refinery in Western Australia will be ready for operation by the end of this year. Foundations for the reformer, the major part of a $9.2 million expansion program, are nearing completion. The reformer will be capable of a 10,000 bbl a day throughput, will produce motor fuel blending component.

Petro-Tex Chemical Corporation is constructing a high-purity isobutylene plant in Houston. Plant will have a capacity of 2 million gal per year and the product will be above 99 percent purity.

Imperial Oil, Ltd., is increasing capacity of its Sarnia, Ontario, refinery from 78,800 to 94,000 bbl per day as a result of a $5.36 million expansion program. This program will include additions to distillation and cracking units and improvements to piping, storage, and blending facilities. Completion is scheduled for mid-1959. A $28.5 million petrochemical plant is scheduled for completion this fall.

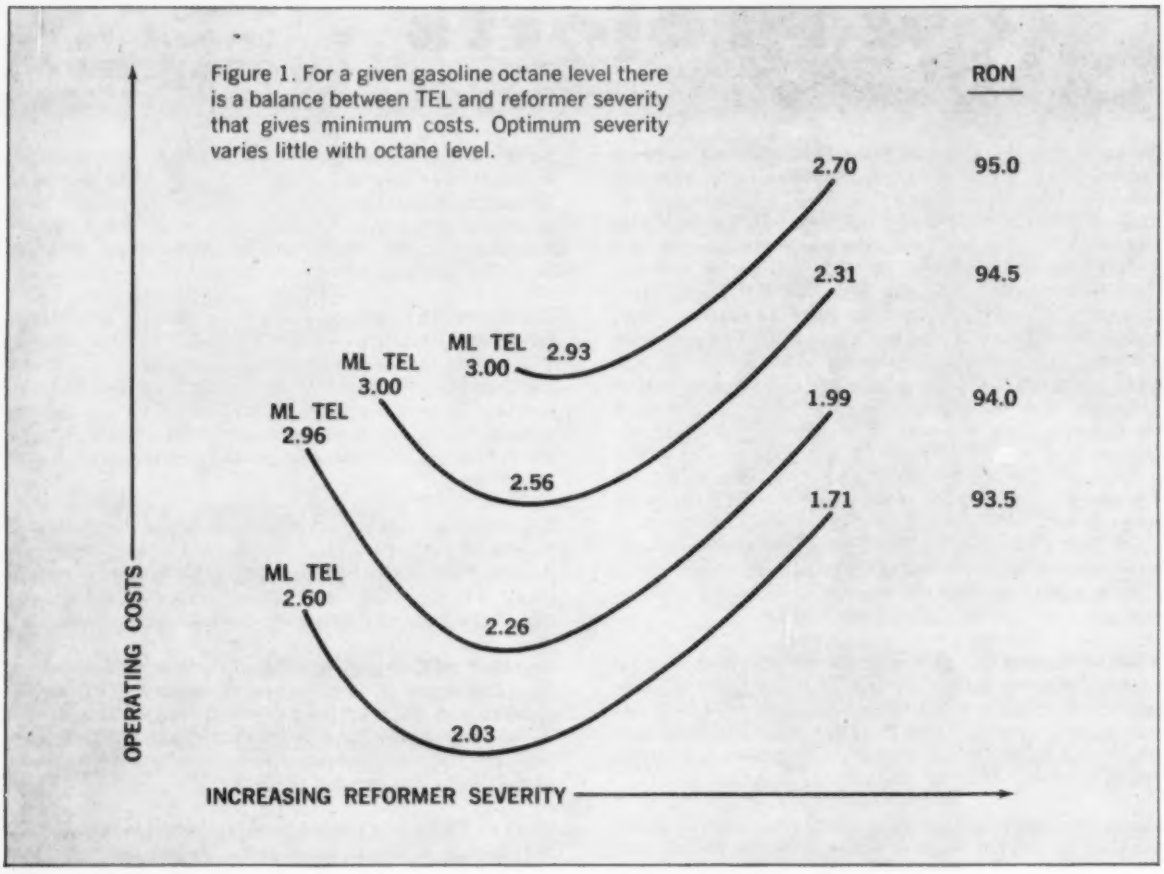

Figure 1. For a given gasoline octane level there is a balance between TEL and reformer severity that gives minimum costs. Optimum severity varies little with octane level.

Ethyl Research Studies Effect of Reduced Charge Rate on Octane-Improvement Costs

Economics of octane improvement are continually under study in the Detroit Laboratories of Ethyl Corporation. Such studies provide a broad background for solving the specific problems of refiners and also in achieving minimum octane costs.

This work is of particular interest now when the refining industry is operating at lower percentage of capacity. In the light of today's reduced charge rates, the Ethyl Corporation investigations show that refiners can realize substantial savings by re-examining their refining operations carefully.

Using rigorous economic analysis, refiners can define the balance between the cost of tetraethyllead and that of octane-improvement processes for a required gasoline pool. Analysis can also define the optimum allocation of tetraethyllead among the various grades of gasolines to be produced from the pool of components.

Tetraethyllead vs. Catalytic Reforming

In catalytic reforming and tetraethyllead the refiner has two means of octane number control. By increasing reforming severity, he increases octane number at the expense of gasoline yield. With tetraethyllead, he increases octane number at the expense of higher concentrations.

There is a definite balance between reforming severity and tetraethyllead concentration that results in minimum cost for any set of conditions.

Figure 1 is a typical plot of cost versus reformer severity for different Research octane number levels. Tetraethyllead concentrations are indicated on the cost curves. They decrease as severity is increased, and the optimum tetraethyllead is defined by the point of minimum cost. As octane number is increased, optimum tetraethyllead rapidly approaches maximum concentration. At the same time, reformer severity increases very little. Figure 1 is representative of many refining situations today.

Octanes Influenced by Crude Charge Rate

The refining industry is operating at a significantly lower per cent of capacity today than it was a year ago. This affects pool octane quality. At reduced crude runs, catalytically cracked gasoline makes up a bigger part of the gasoline pool

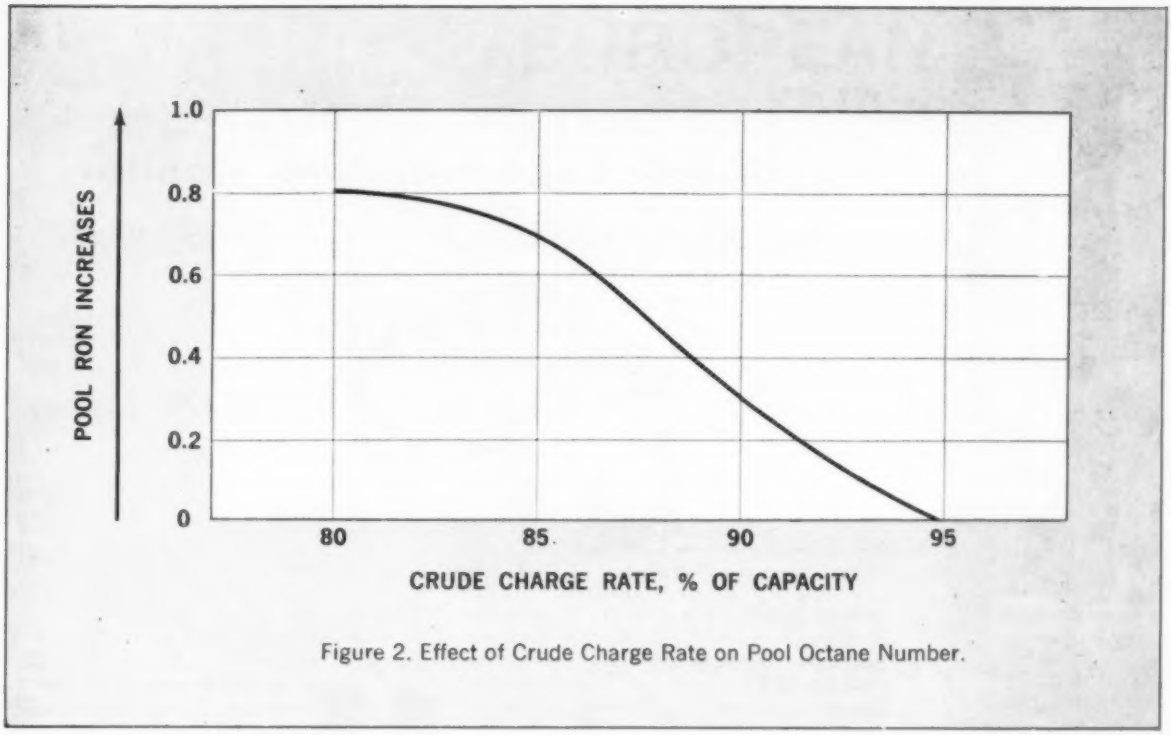

Figure 2. Effect of Crude Charge Rate on Pool Octane Number.

and pool octane quality may be higher.

Also, catalytic reforming capacity, as a function of crude run, is higher which enables a larger percentage of naphtha to be upgraded. Refiners must consider the effects that this stiuation has on their present and planned operations.

Figure 2 illustrates the effect that crude charge rate may have on the RON quality of a gasoline pool. A decrease in the percentage of crude running capacity in operation raises the pool octane number. This effect can be as much as 0.5 to 1.0 octane numbers.

Operations Today are Less Severe than Last Year

At present, relative to a year ago, reforming severity and tetraethyllead in the average refinery have undoubtedly shifted as a result of several factors. The higher ratio of cat cracking capacity and reforming capacity to crude runs enables refiners to produce a given octane quality with less severe operations.

Therefore, in order to make the best use of tetraethyllead and reforming for octane improvement, the balance between reforming and tetraethyllead must be frequently reviewed and studied.

Directionally, at lower percentages of capacity operated, reformer severity should be somewhat less (higher reformate yield) in order to get the most efficient use out of tetraethyllead. The curves shown in Figure 1 would shift to the left under these conditions.

Ethyl Research is constantly testing all of the variables which affect the use of tetraethyllead and the cost of octane-improvements. Results obtained are passed along to the Oil Industry to help individual oil companies achieve optimum production economy.

How Ethyl Research is helping you

Our Refinery Technology staff, backed up by the extensive facilities of the Detroit Laboratories, will be glad to share their experience with your economics people when you conduct an analysis of your octane-improvement costs.

For further information, call your Ethyl Representative. He will be glad to arrange an appointment for you with one of our Refinery Technologists.

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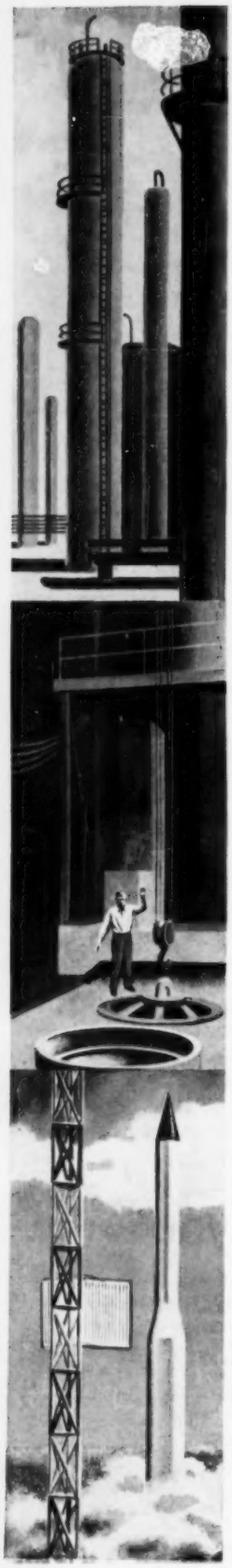


CEC's new

extended-range moisture monitor

...fast, precise readings from 1 to 20,000 ppm

Type 26-302

$750.00 *complete*

Newest addition to CEC's line of moisture monitors, the 26-302 is the only precision instrument designed specifically to measure moisture in gases and gaseous mixtures over the range of from 1 to 20,000 ppm. Instrument features fast response with immediate recovery and is economically priced at $750.00.

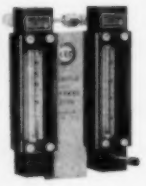
... and for the 0 to 1000 ppm range

CEC's low-cost 26-301

The industry-proven 26-301 gives precise readings from 0 to 1000 ppm, with 63% response to a step-function change in 30 seconds ... 95% response in one minute. Accuracy is guaranteed better than 5%. Complete instrument only **$650.00**

Both the 26-301 and new 26-302 are absolute measuring devices and do not require calibration. They can be equipped with a self-contained, plug-in battery pack for operation in areas where line power is not available.

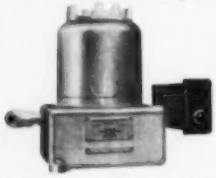
These accessories tailor basic models to custom needs ...



SAMPLE BY-PASS–CEC's 26-011 provides an indication of sample flow through the monitor and assures fast response of the external sample system. It consists of two flowmeters, one connected to the Sample-Out port to indicate flow and the other to purge the sample line.

SAMPLE VAPORIZER–CEC's 26-013 Sample Vaporizer is the newest accessory available for the 26-301 and 26-302. It enables the instruments to monitor moisture content of refrigerant gases or liquids and other gases or liquids having comparable characteristics.

For continuous in-plant measurement ... 26-310 **PROCESS MOISTURE MONITOR**



Consolidated's Process Moisture Monitor accurately measures extremely low concentrations of water vapor in process streams. The 26-310 assures precise regulation of sample flow under rugged process plant conditions, and is ideal for remote recording and control, even in hazardous locations.

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26-302 Extended-Range Moisture Monitor–Bulletin CEC 1849-X3.

26-301 Moisture Monitor–Bulletin CEC 1834-X28.

26-310 Process Moisture Monitor –Bulletin CEC 1845-X13.

26-011 Sample By-Pass and 26-013 Sample Vaporizer Accessories– Bulletin CEC 1848-X3.

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EUROPEAN REFINERY CONSTRUCTION BOOMING!

Western Europe's refining industry is now adding capacity of 1,860,000 bbl per day . . . while there is no sign of cutback now, outlook may change next year depending on recessionary pressures. Here's a complete wrap-up on oil supply, demand and plant construction in this key area

Walter Sekules,
European Correspondent
London, U.K.

EXPANSION of Free Europe's refining capacity is going forward in spite of current difficulties caused by the combination of oil surplus and receding demand. European oil executives currently speak in terms of short-term slackness, but predict, however, another major expansion in demand by 1960, to again bring consumption into line with the confident forecasts made in the middle fifties.

Refinery expansion is seen as a long-term investment; there is no sign yet that major modifications in expansion plans are contemplated. Two factors support this view:

1. Most of last year's increase in European oil imports consisted of refined products, reversing the previous two years' trend toward greater imports of crude.

2. Total Eastern Hemisphere refinery throughput capacity is only 6.25 percent higher than crude production in 1957.

Thus, while the long-term outlook in Europe is still seen optimistically, there is a new note of caution and any persistent recession is likely to cause a reassessment of expansion plans next winter or spring.

Supply/Demand Balance

The tremendous rate of refining capacity expansion in Europe since the war has made the continent practically self-sufficient. However, the rapid consumption increase since 1953 has again outstripped throughput from local refineries. In 1937 imports of refined products accounted for 65 percent of total oil imports. By 1954 this ratio had dropped to 0.15 percent, yet it rose again to 12.65 percent in 1956 and 18 percent in 1957.

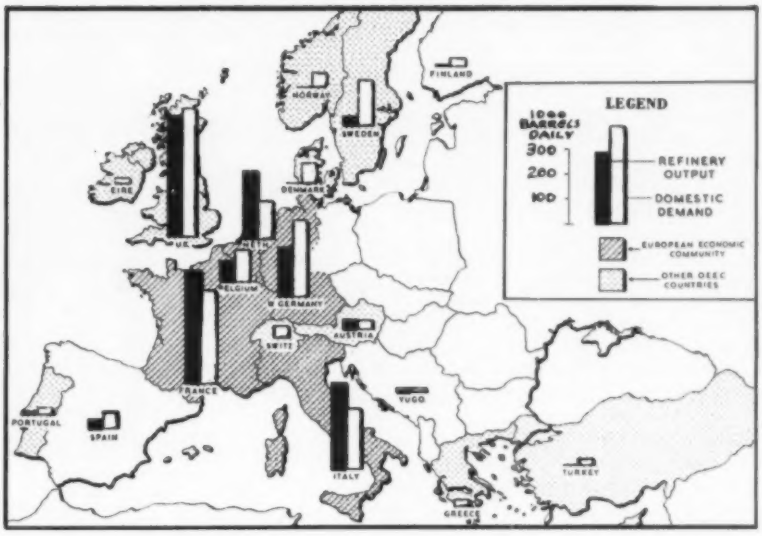


FIG. 1. Refinery output and domestic demand in Western Europe in 1957.
— Source: British Petroleum Company, Ltd.

Expansion is the Vogue

European refining capacity now stands at 2,700,000 bbl daily, an increase of 160,000 bbl daily during 1957. Counting major projects already underway or under consideration, the current expansion program will add 1,860,000 bbl daily: This is two-thirds of all additional refining capacity planned throughout the non-communist world outside North America! Combined cost of this expansion program is estimated at $1,800,000,000.

U. S. capital participation in this program is difficult to estimate. In 1956, the last year for which figures are available, U. S. new investment in Western Europe was $230,000,000, mainly in refineries, but some for finding new crude production.

In the current expansion program, Standard Oil Company (New Jersey)

Estimated Petroleum Supplies into Western Europe, 1953-1957.
(Thousands of Barrels Daily)

	1953	1954	1955	1956	1957
Local Crude Production	135	154	185	212	242
Net Crude Imports	1,500	1,740	1,894	2,008	2,020
Net Products Imports	8	2	146	254	364
Net Products Supply§	1,528	1,764	2,078	2,318	2,468

§ Allowing seven percent refinery fuel and losses on crude supply.

"Emphasis is on high fuel oils yield . . ."

affiliates are installing refinery capacity of about 480,000 bbl daily, Caltex 130,000 bbl daily, Socony Mobil 16,000 bbl daily (allowing for local affiliations and jointly owned plants).

European groups are installing these capacities: Royal Dutch Shell 220,000 bbl daily, British Petroleum 200,000 bbl daily, Petrofina 95,000 bbl daily, Compagnie Francaise des Petroles 40,000 bbl daily, other groups 1,180,000 bbl daily, with the Austrian, Italian, and Spanish state concerns adding 200,000 bbl per day.

Trends in Refinery Locations

The next stage of European refinery expansion will complete the process of locating plants close to major consuming centers. Before the war, few countries in Europe could make local refining economic due to unbalanced demand or low consumption. Refineries serving the major European market were located near the producing oil fields overseas. A single large plant would supply a number of small, widely separated markets with diverse demand patterns.

The war brought two major changes: A tremendous increase in European consumption and chronic balance of payment troubles which accelerated the switch from refined products to crude and from Texas Gulf to Middle East supplies. Political pressure led to a demand for refining self-sufficiency in some countries, development of indigenous crude production made local refineries necessary in others. Emergence of the supertanker made the long-distance transport of crude even more attractive. Accordingly, the first great post-war expansion of European refineries developed near the marine oil terminals.

Now, the second stage is underway: Major refineries are under construction or projected in the great industrial centers in the heart of the European Continent. For example, four refineries with total capacity of 570,000 bbl daily are going up in the Rhineland, close to the German industrial centers of the Ruhr. In France, projects exist for refineries to serve the densely populated Paris region and the heavy industries of Lorraine. These plants will all be linked with ocean terminals by inter-Continental trunk lines.

Pipeline Construction is Active

These pipeline schemes are currently underway or under consideration in Western Europe: In France, the C.F.P. and Pechelbronn-Socantar groups have formed a company to construct a pipeline linking their new 70,000 bbl per day refinery near Strasbourg with the Mediterranean oil port of Berre. Royal Dutch Shell interests are concerned in a study for an even more ambitious pipeline project, linking the Mediterranean at Marseilles with the North Sea at Rotterdam.

A 30-in. trunk line could carry crude either way, and there would be smaller feeder lines to Paris, Strasbourg and Antwerp.

Such a trunk line would shorten the supply route from the Middle East to the great refineries in the Rotterdam area by nearly 2000 miles! It would also supply the new refineries near Strasbourg and Cologne. However, little has been heard of this project since the Suez closure and it is thought that political instability in the Middle East may have caused the hold-up.

In Germany, one group of petroleum interests is going ahead on the construction of a 180-mile pipeline from the North Sea port of Wilhelmshaven to Cologne, capable of carrying 180,000 bbl daily at first, likely to be raised to 400,000 bbl daily. This line will feed the new Esso refinery at Cologne and the British Petroleum plant at Dinslaken. Other European pipeline projects may link Rotterdam and Cologne, Venice and Vienna, and Genoa and Switzerland where an Italian-Swiss group is considering a small refinery project.

Yield Patterns in Europe's Refineries

Differences between the North American and European refining pattern, already great, are likely to spread even more. Europe's heavy emphasis on middle distillates and fuel oils at the expense of gasoline, has two main causes: Consumption of gasoline suffers, due to heavy taxation in all coun-

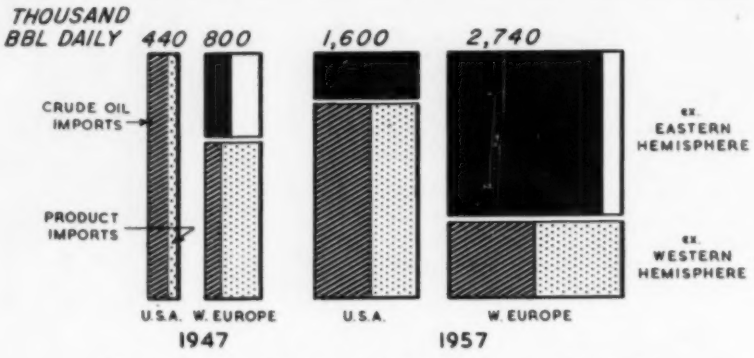


FIG. 2. Oil imports into U.S.A. and Western Europe — 1947 vs 1957.
— Source: British Petroleum Company, Ltd.

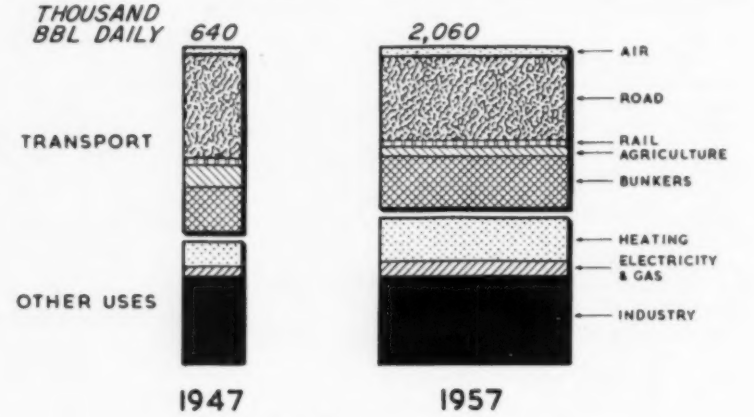


FIG. 3. Main uses of petroleum products in Europe.
— Source: British Petroleum Company, Ltd.

tries, and in some countries even automobiles attract high taxes to encourage export sales.

On the other hand, consumption of fuel oil is boosted by the traditional European energy pattern. Coal always has been—and still is in most countries —the basic source of energy. Expansion of demand for liquid fuel is largely due to stagnating coal production since the war. Unable to meet full demand for energy, coal is being replaced by oil.

Share of petroleum products in total energy requirements has risen from 8 percent pre-war to about 20 percent at present—still low when compared with the world average of 37 percent!

In 1957, refineries in Western Europe showed the yields:

Gasolines	20 percent
Kerosines	4 percent
Gas/Diesel Oil	23 percent
Fuel Oil	35 percent
Others	18 percent
	100 percent

Effect of Demand on Refinery Design

This demand pattern will have a profound effect on the design of new European refineries. Yield of gasolines will not have to be stepped up by the construction of catalytic cracking plants. This will make need for vacuum distillation units questionable. Since cost of catalytic crackers and their auxiliary equipment is higher than any other single piece of refinery equipment, the installed cost of new plant will be rather lower.

It is likely that the increasing demand for higher octane gasolines can be met by reforming rather than cracking. The declining market for aviation gasoline is unlikely to bring much development of plants for this purpose. While two European refineries have recently installed alkylation units, this seems due to the reduced intake from Middle East plants, rather than any expected rise in demand.

European refineries will therefore concentrate on straight distillation with facilities for upgrading gasolines. They will have facilities for production of road diesel fuels and other middle distillates and, especially, for producing residual fuel oils. These refineries may operate at economic levels even if they are rather smaller than present American practice considers advisable.

Price Structure Influenced By North America

The traditional price structure of refinery products, based on the North American market, has placed the European refiner at some disadvantage. Demand for the profitable gasolines is curbed; thus lower-priced middle distillates and fuel oils account for most of the expansion. As most of the large European refineries are operated by integrated companies, this means that refinery runs are, in effect, subsidized by profits from crude production. This pattern has set up stresses which seem to have been released by the Suez Canal closure. Now, the lower differential between light and heavy crude prices is already seen as foreshadowing the long-term trend toward higher prices for fuel oil in relation to other refinery products.

According to one estimate, based on light U. S. or Venezuelan crude, the value per barrel of products refined by simple distillation has risen between 23 and 28 cents, keeping pace with the rise in crude of 25 cents. But, owing to the relative drop in value of the lighter fractions, product yield values on the more complex runs show increases of only 4 to 16 cents, against the 25 cent increase in crude.

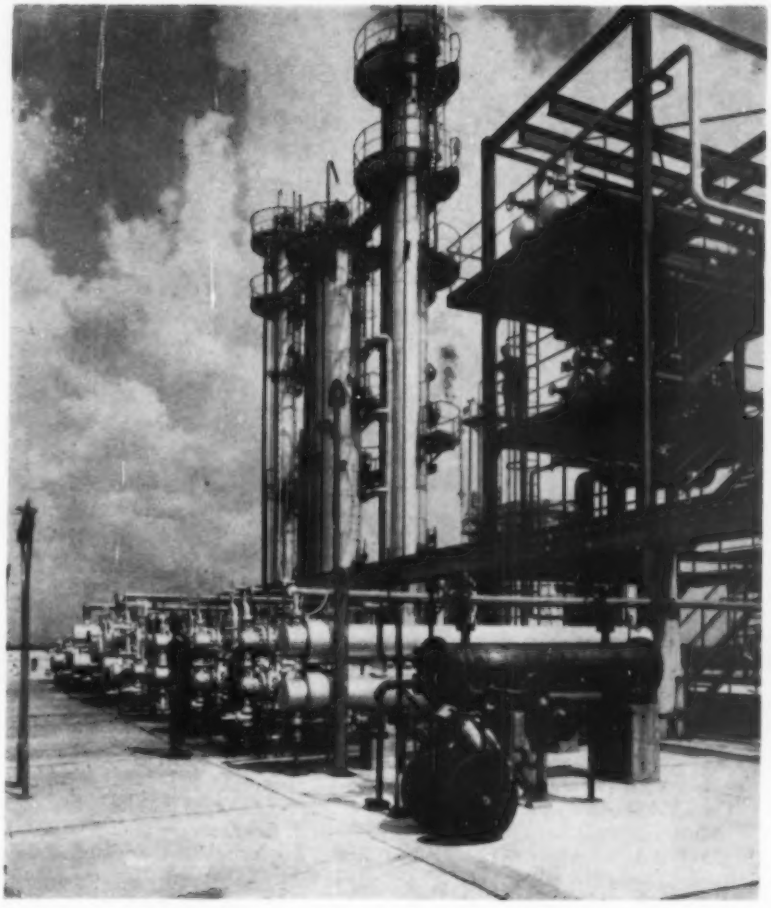
It seems too early to decide whether this relative improvement in the profitability of heavier fractions is a temporary phase pending a recovery of gasoline prices, or whether it is indeed the first indication of a new price structure adapted to the European demand pattern.

Future Expansion of Capacity and Demand

Estimates of European petroleum expansion indicate that consumption will double in the decade between 1955 and 1965 and double again to reach 6,000,000 bbl daily by 1975! It may be assumed that refining capacity will keep pace.

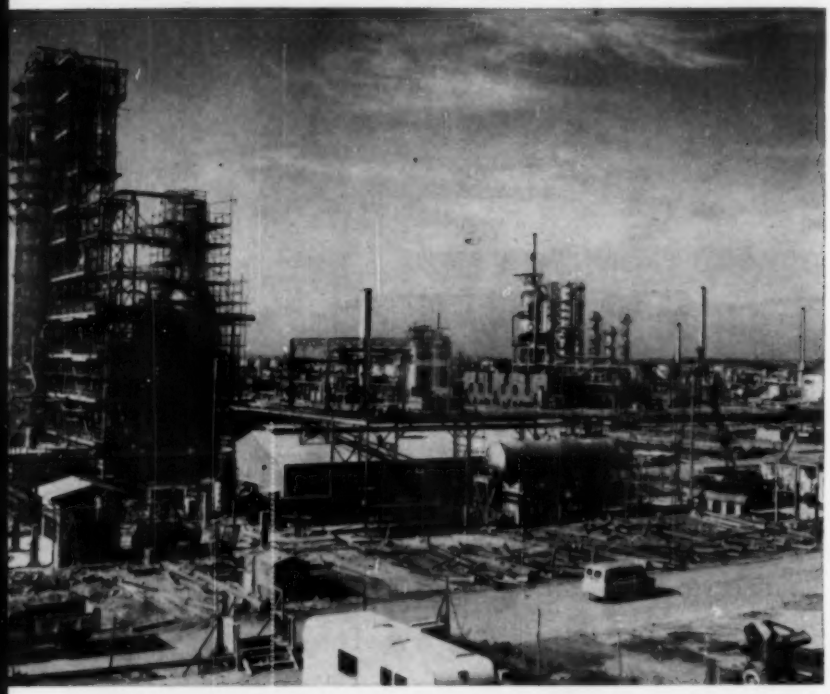
How are the countries of Western Europe planning to expand their refinery capacity? Here is a country-by-country survey.

"Heavy fractions are becoming more profitable . . ."



Platformer at the Deutche Shell refinery at Harburg, near Hamburg, Western Germany. New units now going onstream at this plant will increase its capacity from 900,000 tons per year up to 2,500,000 tons annually. — *A Shell Photograph.*

"U.K. products consumption to double by 1970..."



The British Petroleum Company's Kent refinery. This photo shows the No. 2 Distillation Unit nearing completion during a huge expansion project at Kent refinery.

— Source: British Petroleum Company, Ltd.

United Kingdom. Since 1946 British refinery capacity has increased from 87,000 bbl daily to 600,000 bbl daily. Total oil consumption last year, 173,000,000 bbl, was 1.9 percent lower than 1956, largely due to gasoline rationing in the first quarter of the year. Consumption of petroleum products is expected to double by 1970; refinery expansion plans currently call for 400,000 bbl per day additional capacity.

Esso is building a new refinery at Milford Haven, Wales, first stage to be completed by 1960. Initial throughput will be 110,000 bbl daily, but this is expected to double over the following eight years. This will be a straight refining plant, estimated to cost $56,000,000.

For some time Caltex have been planning a 20,000 bbl per day refinery near Southampton, but no definite plans have been announced yet.

Four of Britain's largest refineries are currently completing expansion programs. At Kent refinery, the British Petroleum Company is doubling capacity to 180,000 bbl daily at a cost of $73,000,000. Expansion is due to increasing European fuel oil demand and need to manufacture aviation gasoline; BP can now rely on only 40 percent of Abadan refinery output under the Iranian consortium agreement. New units at Kent refinery include a 90,000 bbl daily crude distillation unit, a stabilizer of 12,000 bbl daily capacity, a 12,000 bbl per day thermal reformer, a 10,000 bbl per day catalytic reformer, two Hydrofiners of 10,000 bbl daily capacity, and an alkylation plant of 2250 bbl per day capacity. A total of 21 new units are being installed at Kent refinery.

At Grangemouth refinery, British Petroleum Company is spending $17,000,000 to increase capacity from 44,000 to 62,000 bbl daily. A new crude distillation unit will replace part of the existing distillation plant, a copper chloride unit will increase propane output, and gas oil and kerosine treatment units are being installed. The distillation unit should be ready early next year, other units by the end of 1959.

Esso has installed a third crude distillation unit of 70,000 bbl per day capacity at Fawley refinery, bringing total capacity to 210,000 bbl daily. Two more Hydrofiners have been installed and a sulfur recovery unit is under construction.

At Stanlow refinery, Shell Petroleum Company has carried out no major work recently, except for the installation of a $2,000,000 Udex unit to make avgas blending components. Shell Haven refinery is doubling distillation capacity to 155,000 bbl daily with the addition of an 80,000 bbl per day crude unit later this year.

France. Virtually self-sufficient in refining capacity already, France intends to install another 200,000 bbl per day capacity according to a five-year economic plan announced by the government in 1957.

Present capacity is 600,000 bbl per day, an increase from 480,000 bbl daily since 1952. French oil consumption has risen 58 percent since 1952; petroleum products cover about 23 percent of the country's energy needs.

Consumption is expected to increase by one-third by 1961, fully covered by new refining plants. Two new refineries are to be constructed in the Strasbourg area. One, to be operated by Shell Berre and Caltex, is expected to come onstream in 1962 with initial capacity of 60,000 bbl daily. The CPF-CFR groups are building the second Strasbourg refinery in association with Strasbourg port authorities, Pechelbronn and possibly other interests. Capacity will be 80,000 bbl daily. The same group is interested in the Strasbourg-Mediterranean pipeline project.

Esso's new refinery in the Bordeaux region at Bec d'Ambes, 30,000 bbl per day capacity, should go onstream in 1959.

Expansion schemes at existing refineries include virtual doubling of capacity at L'Avera refinery operated by the SFP-British Petroleum interests. Installation of a new crude still has raised capacity to 80,000 bbl daily. Dunkirk refinery, operated by the same group, is completing a catalytic reformer of 10,000 bbl daily capacity. At Petit Couronne refinery Shell Berre is completing an 80,000 bbl per day distillation unit, and a catalytic reformer of 13,000 bbl daily capacity is due for completion in 1959.

Germany (Federal Republic) Consumption of petroleum products, now at the rate of 300,000 bbl per day, is expected to rise to 600,000 by 1960 and 840,000 bbl per day by 1965. Refining capacity in the Federal Republic is now 316,000 bbl per day, but many plants are small and obsolete.

Germany has the most ambitious refinery expansion scheme in Western Europe with plans for installing another 600,000 bbl per day capacity. By far the biggest refinery currently under construction is the Esso plant at Cologne, due to go onstream with 70,000 bbl per day capacity this year and to be in full operation at 150,000 bbl per day by 1962. It will include a steam cracking plant, costing $15,000,000 to produce gaseous olefins from distillate gasolines.

Delayed Coking

Designed by: The Lummus Company

DESCRIPTION: Delayed coking provides an efficient means of converting heavy residues, such as vacuum asphalts, into high yields of gas oil suitable for catalytic cracking. If the feed stock is low in sulfur, the coke can be used for electro-metallurgical purposes. Otherwise it is usually burned as fuel.

Hot vacuum bottoms are pumped directly to the bottom of the coker fractionator, where they mix with recycle. The combined steam is pumped through a specially designed heater to the coke drums. These are installed in pairs; smaller units have two drums, larger ones four, or even six. While one drum of the pair is being filled, the coke in the other is being removed by hydraulic jets using high pressure water.

Vapors from the drum pass to the fractionator, where they are separated into recycle, gas oil, unstabilized gasoline and wet gas. The gas oil is of high quality, and is suitable for catalytic cracking. Many refiners, however, split the gas oil into a light fraction, which is treated and blended into distillate fuels; and a heavy fraction which goes to cracking.

TYPICAL YIELDS AND PRODUCT QUALITIES:

The tables of yield and product specifications and the delayed-coker flow diagram illustrate an operation based on processing a heavy Tia Juana vacuum residue. A significant feature of this operation is the 41.6 vol. percent yield of gas oil for catalytic cracking and 35.6 wt. percent yield of coke from a residue with a 5 percent boiling point of 1,015°F.

PRODUCT YIELD SUMMARY

	B/SD	A.P.I.	Lb. Hr.	Weight %	Vol. %
Charge	9,660	7.7	143,120	100.0	100.0
Product:					
Wet gas			11,310	7.9	
Unstabilized gasoline	2,678	60.5	28,770	20.1	27.7
Gas oil	4,016		52,090	36.4	41.6
Coke			50,950	35.6	

CHARGE AND PRODUCT SPECIFICATIONS

Charge Stock

Gravity, °API	7.7
Vis., S.F.s. at 210°F	1,200
Con. Carb., Wt. Percent	20.9
Vac. Dist., Corrected to 760 mm	
I.B.P., °F	860
5 Percent Point, °F	1,015

Debutanized Gasoline

Gravity, °API	56.8
R.V.P., psi	4.0
Res. Octane, Clear	64.0
ASTM Dist., °F.:	
95 Percent	375
EP, °F	400

Wet Gas (Mol. Wt. = 30.7)

	Mol. %
C_2 & Lighter	69.2
C_3's	16.2
C_4's	7.6
C_5+	6.0

Gas Oil

Gravity, °API	27.5
Con. Carb., Wt. Percent	0.10
Sulfur, Wt. Percent	2.2
Vac. Dist., Corrected to 760 mm.	
IBP, °F	410
EP, °F	950

SERVICE FACTOR: 95 Percent

UTILITIES — (Includes decoking, but not vapor recovery and stabilization)

	B/SD 5,000	B/SD 10,000
Fuel, MM btu/hr.	42	84
Cooling Water, gpm	1,750	3,500
Electric Power, kwh/day	8,500	14,000
Process Steam, lbs/day	52,000	80,000
Industrial Water, gals/day	75,000	150,000
Steam Generation, lbs/hr.	8,500	17,000

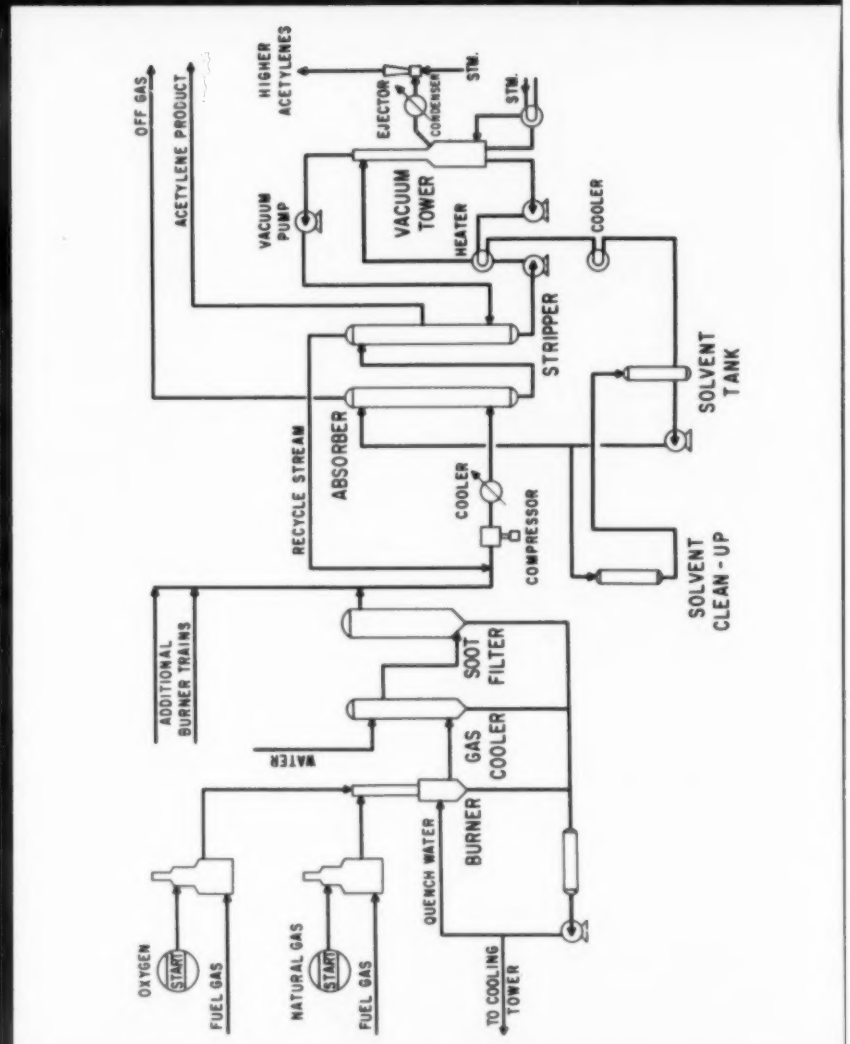
OPERATING PERSONNEL: Four men per shift, plus a three man crew for each drum decoked.

INVESTMENT: (U.S. Gulf Coast, early 1958, vapor recovery and stabilization not included)

Capacity B/SD	Type of Feed Stock	$, Thousands
10,000	Asphaltic	4,800
10,000	Paraffinic	3,300
5,000	Asphaltic	2,900
5,000	Paraffinic	2,100

BASF Process For Acetylene Production

Licensed by: Chemical Construction Corporation



BASF Process For Acetylene Production

Licensed by: Chemical Construction Corporation

DESCRIPTION: The BASF acetylene process produces acetylene by partial oxidation of hydrocarbons by oxygen. Hydrocarbon feedstock may be natural gas, ethane or propane. Plant consists of a synthesis section made up of multiples of burner trains, a compression section and refining section. Individual burner trains have capacity for 16 tons per day of product acetylene.

Acetylene is formed in a flame reaction in a specially designed burner where part of the preheated hydrocarbon is burned with preheated oxygen to attain temperature level and supply heat of reaction. After quenching, exit burner gas is further cooled and cleaned by water scrubbing and passage through a soot filter consisting of a bed of granular coke.

Burner gas is then compressed and sent to the refining section. Actylene, higher acetylenes and some CO_2 are absorbed in a selective solvent at elevated pressure in the absorber. Lean off-gas, consisting mainly of carbon monoxide and hydrogen, passes from the top. CO_2 is removed from the rich solvent by flashing and stripping in the stripper and high purity product acetylene is withdrawn as a side stream from the same tower.

Before recycling the solvent to the absorption step, higher acetylenes and water are removed by stripping under reduced pressure in a vacuum tower. A small side stream of solvent is removed continuously from the cycle for clean up and returned to the cycle.

Off-gas, rich in carbon monoxide and hydrogen, produced in the refining section is eminently suitable for ammonia or methanol production. An ammonia or methanol plant based on off-gas as feedstock can realize a reduced investment over conventional routes and at the same time result in economics in the acetylene plant by realizing a higher value than the fuel equivalent for this valuable by-product.

FEEDSTOCK:

Hydrocarbons

Natural Gas — Oxygen — 95%
Ethane
Propane

YIELDS:

Overall yield of acetylene, based on carbon in feedstock, is 30%. Product acetylene purity it 99%+. Major impurities are propadiene, methyl acetylene and carbon dioxide.

SERVICE FACTOR: 90% minimum.

MATERIALS & UTILITIES REQUIREMENTS

(basis — natural gas feedstock)

	Per Ton 100% Acetylene
Natural Gas (process & fuel)	217.9 M scf
Oxygen (100% as 95%)	4.8 tons
Solvent	6 lb
Coke	20 lb
Steam (400 psig)	14.8 M lb
Power	1970 kwh
Cooling Water	71.6 M gal
Make-up Water	12.0 M gal
Credit	
Off-Gas (305 btu/cf)	358.3 M scf

OPERATING MANPOWER:

Foreman	1 man per shift
Operators & Helpers	4 men per shift

INVESTMENT:

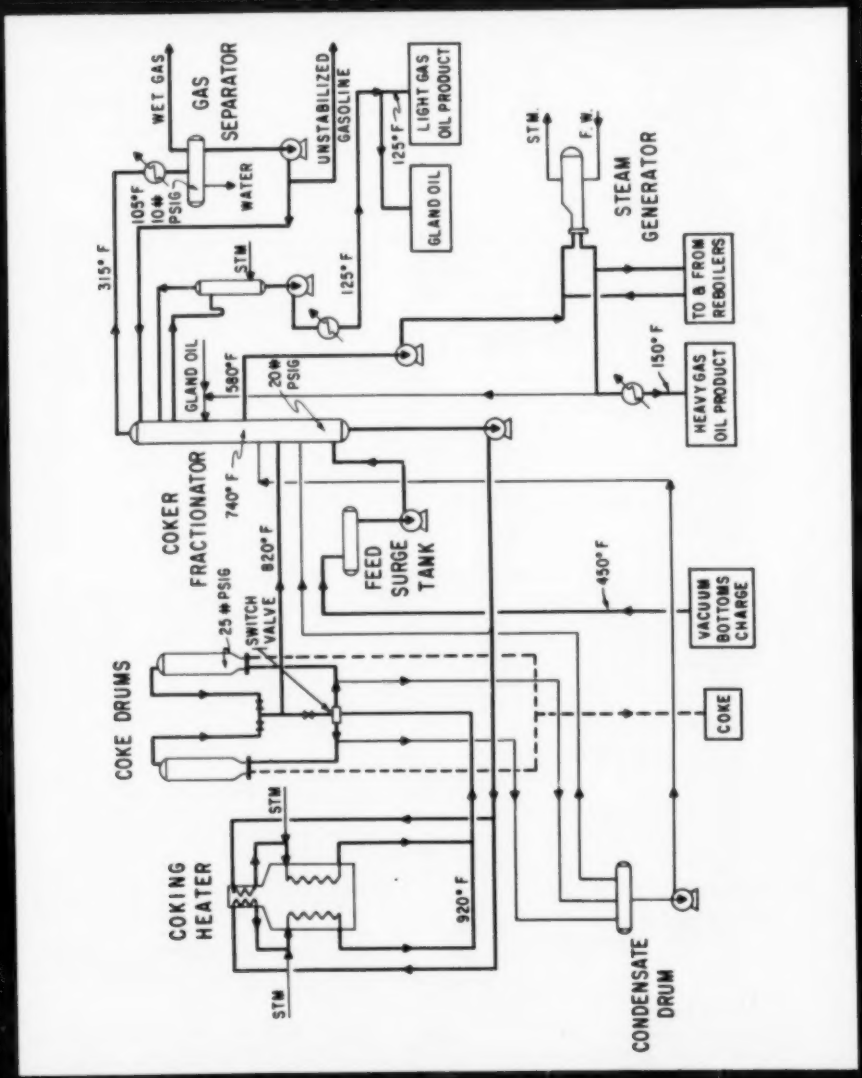
Capacity, T/SD	$, Thousands
48	5,000
80	7,000

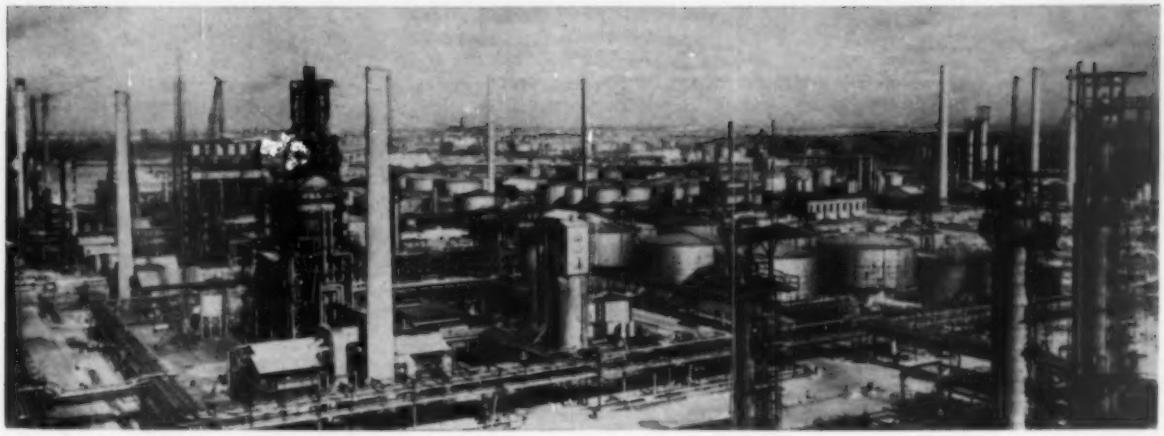
MAINTENANCE:

Total for material and labor: 4% of investment.

Delayed Coking

Designed by: The Lummus Company





Construction activity is evident in this recent photo of the N.V. de Bataafsche Petroleum Maatschappij (Royal Dutch Shell Group) Rotterdam-Pernis refinery in the Netherlands.
— *A Shell Photograph.*

The Shell group has started construction of an 80,000 bbl per day refinery at Godorf, near Cologne on the Rhine. Due to go onstream in 1961, it will cost $60,000,000. This plant will concentrate on production of fuel oil and diesel oil, light fractions accounting for less than 20 percent of throughput. An oil harbor is being built in the Rhine for this refinery.

The British Petroleum Company is about to start construction of a refinery at Dinslaken, in the Ruhr area, with capacity for 80,000 bbl daily. Also intended mainly for fuel oil, it should come onstream in 1960.

The fourth new refinery in the Rhine-Ruhr district will be built by the Belgian Petrofina group at Duisburg-Neuenkamp. It is due to go onstream with 25,000 bbl daily capacity in 1959, to be increased to 60,000 bbl per day by 1961.

Both the Getty and Aminoil companies, producing crude in the Saudi Arabia/Kuwait neutral zone, are interested in German refinery projects. Getty Oil is planning a 70,000 bbl per day refinery in the Lower Rhine region, while Aminoil is reportedly interested in a 30,000 bbl per day refinery planned by the Swiss Duttweiler concern at Emden.

Major expansion projects are also underway at existing German refineries. At Hamburg-Hohe Schaar, the Shell refinery is completing a major expansion from 1500 bbl per day to 36,000 bbl per day. Two Platformers and a hydrodesulfurizer were completed last year and two major units are to come into operation this year. Lingen refinery, operated by the Wintershall and Elwerath groups, is raising capacity from the current 17,000 to 50,000 bbl per day. The Gelsenkirchen refinery of Scholven Chemie has an expansion scheme underway to double capacity to 40,000 bbl daily. It will start producing fuel oil at the rate of 15,000 bbl per day.

Italy. With 520,000 bbl per day refining capacity, Italy has a big surplus and no major expansions are contemplated. The Petrofina group has plans for a new refinery at Fiumicino near Rome to replace the old Purfina plant in the Rome area which is being dismantled. While the Italian government has discouraged more refinery projects on the mainland, plans exist for a number of new plants in Sicily.

Netherlands. Europe's largest exporter of refinery products, the Netherlands increased internal consumption of petroleum at the rate of 23 percent in 1955 and 1956, and showed an increase of 5 percent last year. Consumption has doubled since 1951 and is expected to double again in 10 years.

Esso is building a 90,000 bbl per day refinery at Botlek near Rotterdam. To go onstream in 1960, it will cost $29,000,000.

At Shell's Pernis refinery—Europe's largest—throughput last year totaled nearly 250,000 bbl daily. A feed preparation unit for the catalytic crackers was brought into operation last year and an alkylation plant with 2800 bbl per day capacity was started up this spring. Two hydrodesulfurizers are under construction to complete the fifth phase of the refinery's post-war expansion program.

Capacity of the Caltex refinery, also at Pernis, is being doubled to 100,000 bbl per day.

Belgium. Consumption at the current rate of 100,000 bbl per day is largely met by local refineries, whose capacity is 130,000 bbl daily. Only major expansion scheme is at the Petrofina-British Petroleum refinery at Antwerp, with capacity being raised to 120,000 bbl daily. One Hydrofiner of 8000 bbl daily capacity and a 7000 bbl per day catalytic reformer are being commissioned in mid-1958.

The 33,000 bbl per day Esso refinery at Antwerp is installing a 5000 bbl per day catalytic reformer and a 6000 bbl per day Hydrofiner.

Austria. The country's first major post-war refinery is now under construction at Schwechat near Vienna. Built by the state-owned OMV concern, it will cost $40,000,000. It will go onstream in 1959 with 30,000 bbl per day capacity, to be raised to 50,000 bbl daily by 1962.

Scandinavia. Three principal refineries in this region, all in Sweden, are owned by local interests. Esso has started construction of Norway's first refinery near Oslo, to cost $30,000,000. Due to go onstream in 1960, its capacity will be 40,000 bbl per day. Initially, this refinery will supply about 20,000 bbl per day to Esso marketing companies in Sweden and Denmark. By 1970 the Norwegian market is expected to absorb the whole throughput. In Sweden, refinery capacity is to be raised to 60,000 bbl per day through extensions at Nynashamn refinery.

Irish Republic. A refinery is under construction at Whitegate Bay with the participation of three major marketing groups—Esso, Caltex and Shell Mex-BP. Capacity will be 40,000 bbl per day; the plant is due to go onstream in 1959.

Spain. Consumption is expected to rise to 110,000 bbl daily in 1960. Spain is almost self-sufficient in refining capacity at present. Caltex has a 24 percent share in the country's main refining plant at Escrombreras. It is due to increase capacity from 70,000 to 80,000 bbl per day by 1960. The INI concern plans to build a new 25,000 bbl per day refinery at Puertollano, south of Madrid. ★ ★ ★

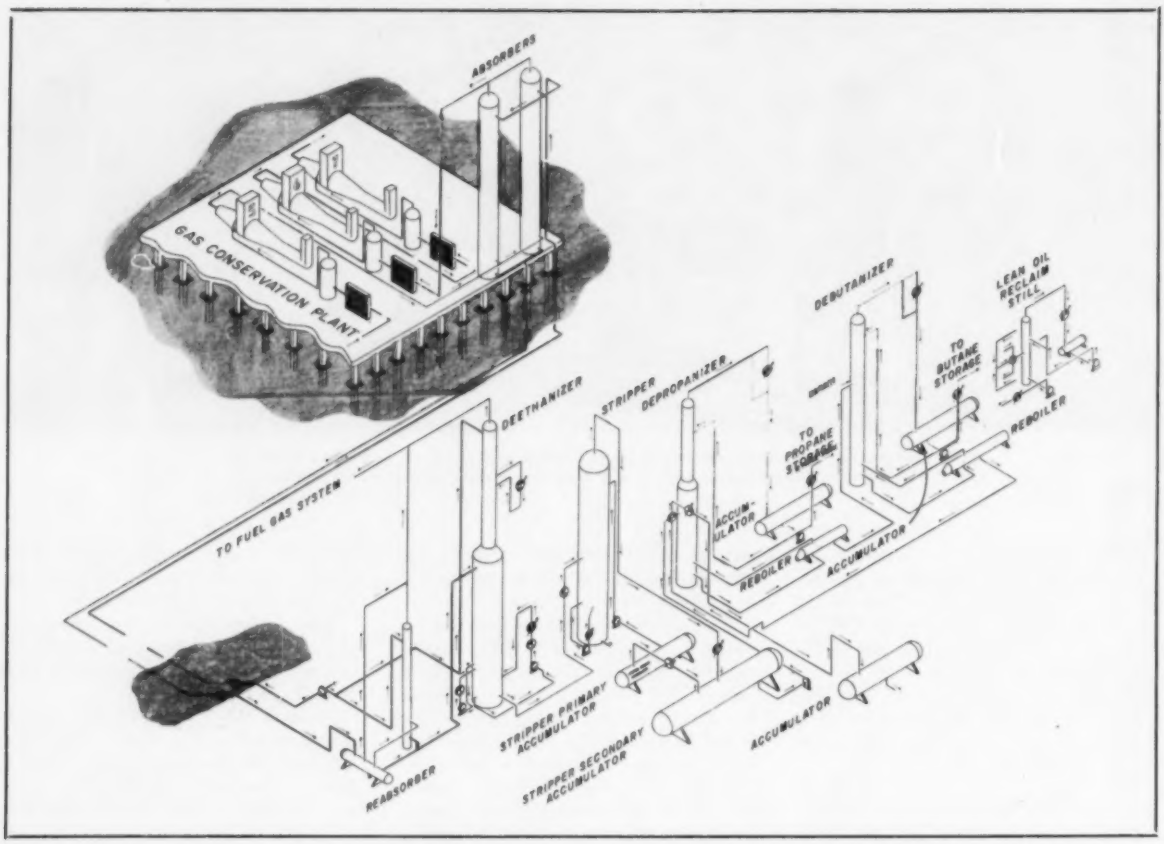


FIG. 1. The offshore absorbers are seven miles from land at the Ulé gas conservation project. Rich oil from the absorbers is processed in the Ulé shore-side plant, with pipelines carrying products to a loading port eight miles away. Also see Fig. 2 for layout of facilities.

Completion of the huge Ule LPG Plant means that . . .

Creole Petroleum Now Exports LPG

Dr. Rafael Tudela R.
Creole Petroleum Corporation
Caracas, Venezuela

Dr. Rafael Tudela was born in Caracas in July 1931. After completing his elementary and high school education in Argentina and Venezuela, he was granted a Creole scholarship to proceed with his engineering education in the United States. He graduated from the University of Houston as a Mechanical Engineer in February 1954. For training purposes he worked for Creole in Eastern Venezuela during summer vacations, and since his graduation has worked for Creole in Tia Juana, Maracaibo and Caracas. At present Tudela is a construction engineer in the Gas Section of Creole's Production Department.

FIRST SHIPMENT of liquefied petroleum gases to be exported from Venezuela was made in April of this year. It consisted of 10,000 bbl of commercial propane for consumption in the Caribbean area. Butane shipments will start in the first quarter of 1959 when construction of a specially designed 32,300 DWT tanker with a butane capacity of 75,000 bbl plus complementary fuel oil cargo will be completed, or earlier, if a vessel can be chartered.

Creole Petroleum Corporation's Ulé LPG Plant One located at Ulé, Zulia, Western Venezuela, recently completed except for butane storage now under construction, is in operation. This marks a major step in a vast program for maximum gas conservation and utilization. Designed to process 180 million cu ft of gas per day, the plant will recover at design conditions 5300 bbl per day of propane, 5600 bbl per day of mixed butanes and 6000 bbl per day of natural gasoline. Based on product recovery it is the largest plant in Latin America and one of the largest in the world. A portion of the plant's products will be sold locally although the bulk of production will be exported to the Caribbean area and the United States.

Absorption Facilities are Seven Miles Offshore

The three principal parts of the plant and its facilities; absorption, process and storage, and tanker loading, are

located in three different areas. One of the unique aspects of the plant is that its absorption facilities are located seven miles offshore and to the southwest of the LPG plant proper.

Reabsorber, rich-oil deethanizer, stripper, depropanizer, debutanizer, oil reclaimer, truck loading facilities, etc., are located on land at the process area. All towers for the plant are equipped for optimum efficiency with jet trays designed and patented by Esso Research and Engineering Company.

Storage facilities adjacent to the processing plant, include three 256 ft long by 12 ft diam propane cylinders with combined capacity of 15,000 bbl. Under construction are three 69 ft diam, 90 psig butane spheres with combined capacity for 90,000 bbl. In addition, there are two 80,000 bbl cone roof tanks for gasoline storage. Loading pumps at Ulé have a combined capacity of 11,000 bbl per hour for propane and/or butane through two pipelines 10 in. and 16 in. in diam. These are used for transfer of products to a tanker loading pier located in La Salina, some eight miles away.

Process Operations

Gas associated with the production of oil in Lake Maracaibo is separated at flow stations. It is conveyed to Conservation Plant Tía Juana One (located on a concrete platform built in 62 ft of water in Lake Maracaibo) through an underwater gas gathering system network. This 60,000 hp seven stage, gas-turbine centrifugal-compressor installation is used to conserve 180 million cu ft of gas per day and at the same time repressure for increased oil recovery the LL-370 reservoir underneath the lake.

Wet gas from the fifth stage compressor discharge, at 685 psig, is circulated through two 8.5 ft diam absorbers located on this platform and returned through a scrubber to the sixth stage for further compression and injection into the reservoir. Gas connections to the absorbers, which normally operate on the fifth stage compressor discharge, are manifolded with hydraulically operated valves to switch from the fifth to the fourth stage discharge when either the fifth, sixth or seventh stage Conservation Plant compressors are out of service. When any of the compressor stages is out, the absorber pressure changes, with consequent variation of process conditions. Due to distance between the absorbers and the plant, there is enough time lag to allow adjustment of process units to new conditions.

Lean-oil is fed to the absorbers from shore, through a seven mile, 12 in. pipeline, while rich oil mixed with compression condensate is delivered to the process area through a parallel 12 in. line.

On shore, after going through the flash drum and a reabsorber, rich oil flows to a deethanizer consisting of two sections having an overall height of 108 ft, with a bottom diam of 12.5 ft and top diam of 6.5 ft. The bottom section of this tower is operated as a stripper while its top section acts an an absorber. This allows complete stripping of the bottom product without appreciable loss of product in overhead vapors. The tower has 38 trays.

Deethanizer and reabsorber overhead gases are scrubbed and used for fuel. Excess gas goes to the Bolívar Coastal Fields fuel gas system that serves the company facilities in the Lake Maracaibo Area.

Deethanized rich oil flows to the stripping still, a 69 ft high by 12.5 ft diam tower with 20 trays. Here, rich oil is steam stripped in the bottom section and fractionated at the top. As seen in the flow diagram, still overhead vapors are condensed in two stages. This design was chosen to allow cooling water from other coolers and condensers to be reused in the still primary condenser, thereby minimizing cooling system investment.

Condensed LPG and gasoline are forwarded on level control through the depropanizer (feed heater into the depropanizer) column. Stripped lean oil flows by pressure differential from the base of the stripper to main lean-oil pumps.

Two columns are used for fractionation of propane and butane. They are equipped with 30 and 25 trays, respectively, and horizontal, elevated, overhead condensers and kettle-type reboilers.

Both products are pumped through coolers to the storage area. The gasoline product flows from the debutanizer reboiler on level control through a cooler into a surge tank, and from there pumped to storage.

Lean-oil make-up is produced from

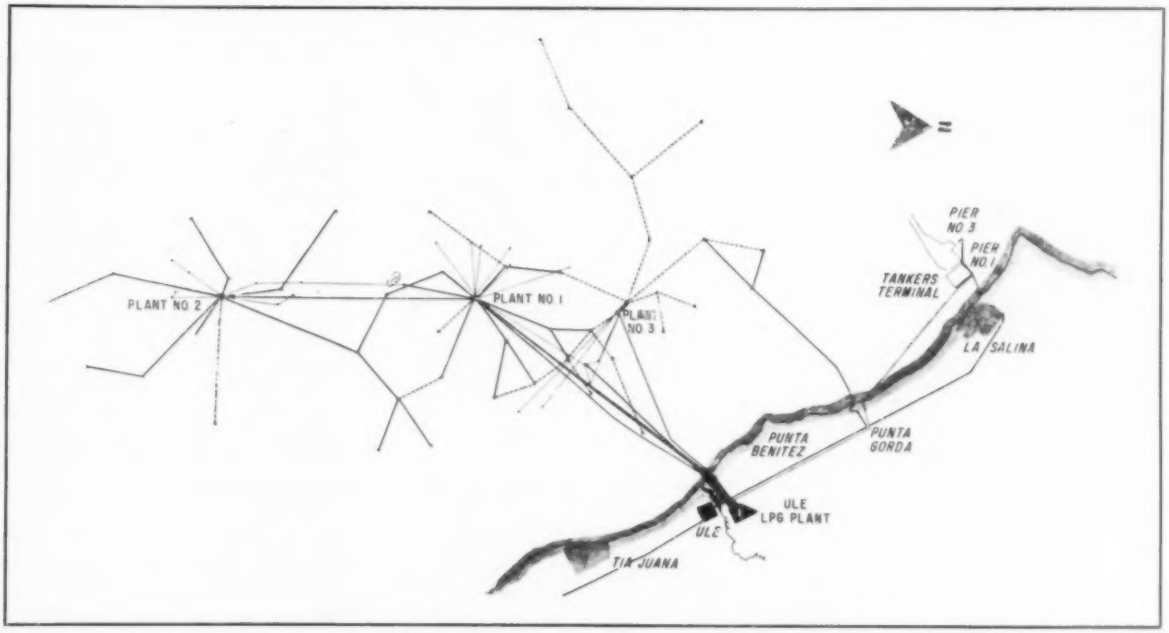


FIG. 2. Gathering systems, pipelines and plant locations for the Lake Maracaibo gas conservation project.

raw crude oil, in the lean-oil reclaim still.

Storage Area and Product Handling

Pumps located adjacent to storage area provide for transfer of stored products as follows:

1. Butane and/or propane separately and simultaneously to the tanker.
2. Butane and propane surplus to sales requirement to Conservation Plant Tia Juana One for turbine fuel.
3. Butane and/or propane to truck loading rack.
4. Off-spec product to process rerun.

Nine miles of 10 and 16 in. pipelines are used to transfer products to the tanker loading pier. Traps for launching and receiving displacement pigs, pigsigs which signal the passage of the pigs, and complete manifolding at the terminal points of these lines provide for displacement of one product by the other. Due to length of these pipelines and high cost of LPG storage, they were considered as an integral part of storage capacity in design of the plant.

Transfer of stored products as outlined above is accomplished by remote control, from a graphic panel in the main control room. All pumps are started electrically from this panel and are additionally provided with "hand-off automatic" switches located at the pumps. In the same manner, this panel is designed to operate electrically actuated, hydraulically-operated valves necessary for this type of automatic installation.

Each of the propane and butane tanks have electronic gage and level transmitters which transmit liquid-level readings to the control panel where the operator can select appropriate tanks for receiving and dispatching products.

Gasoline tanks are located in the tank farm of the Ulé pump station, some two miles from the main storage area.

Pressure relief valves are provided on LPG storage tanks and connected to a product flare stack. Hand operated vents from each tank to the flare are also provided as an additional safety measure.

Utilities

Cooling water for the plant is obtained from Lake Maracaibo and pumped into the plant inlet header through 8500 ft of 30 in. pipe. Three vertical supply pumps are located on a lake concrete platform in 15 ft of water. One is a spare and two are in continuous operation, providing the 12,800 gal per min of cooling water required for the plant. The spare pump starts automatically on failure of any of the other two pumps.

Used water drains into the Ulé River nearby and returns to the lake. Maximum use of the water is attained in this open system by cooling the stripper primary condenser with water already used in the propane, gasoline, butane, and jacket water coolers, deethanizer intercooler and stripper secondary condenser.

Because of the extremely corrosive nature of the Lake Maracaibo water, cement-lined steel pipe and special materials such as aluminum brass, aluminum bronze and stainless steel were used throughout the water system.

Electrical system for the plant is a complete secondary selective system, fully automatic, with lock-out features in case of line failures. Incoming service is 6900 v and consists of two circuits, each of which serves two 750 kva transformers and one 700 hp butane tanker loading pump which operates at 6900 v.

The two transformers are interconnected on the secondary side, through switch gear, by means of automatic transfer and cubicle, which in case of one line failure takes a selected load from the other line allowing plant to operate at nearby full capacity.

The entire plant is fed with a 480 voltage distribution system which serves all motors. Through individual transformers it serves 120/208 v 3-phase and single-phase circuits.

Steam for the plant is supplied by three water-tube, gas-fired boilers. They are designed to furnish a total of 164,000 lb per hr of 300 psig saturated steam.

Utility air for maintenance and other uses is available throughout the plant. Instrument air for the plant system along with starting air for the gas-engine driven lean-oil pumps is available from separate systems.

Of particular interest is the plant's closed vent system which provides for removal of all vapors heavier than air to the flare stack. All vent lines and relief valves are connected into this system except those containing vapors lighter than air such as the reabsorber, rich oil deethanizer, flash drum and deethanizer knockout drum. The vent system includes a blow-down drum upstream of the flare. This drum is fitted with a steam coil to vaporize liquid accumulations.

The vent stack is equipped with a smokeless burner and pilot. The pilot burns fuel gas and is remotely lighted by a flame-front generator. Steam, on pressure control automatically causes smokeless burning by proper agitation and air mixing. A blowdown valve is provided at the base of the stack to remove any liquid build-up.

Fire Protection

The fire water system is designed to deliver 2,500 gal per min of lake water through an 8-in. fire main loop that encircles process and storage areas. Post indicator valves are located in the fire main to isolate various sections throughout the area.

Twenty-four hydrants are strategically located to cover any area with a 250 ft length of 2½-in. fire hose. In addition, several small 1½-in. hand hoses with fog nozzles are provided for protection of personnel, handling of small leaks, small fires, etc. There are seven monitor nozzles located in the process area, each rated at 600 gal per min.

Two fire pumps, one diesel-engine driven and the other electrically driven, take suction from lake water supplied to the plant through a 30 in. diam line. These pumps have a rated capacity of 2500 gal per min at 100 and 125 psig discharge pressure, respectively. One of the pumps has an emergency suction line to a 2000 bbl fresh water storage tank.

The whole system is maintained under continuous pressure by a third smaller pump, and supplies water to the hydrants and also to the sprinkler systems for the protection of propane storage cylinders, butane storage spheres and truck loading rack. To protect the propane and butane tanks, two automatically controlled sprinkler systems are provided.

A dike separates the storage tanks from the process plant. This area has been graded to provide a proper and natural drainage away from any dangerous location.

Propane and butane loading lines to the tanker loading pier are valved at several points to shut off flow in the event of a line break or leak. This is accomplished by pneumatically-operated valves that close on loss or sudden reduction in line pressure.

Loading rack facilities on the tanker loading pier are insulated with one hour fire retardant material. In addition, all facilities on the pier area are protected by two fire pumps, a sprinkler system, and 1½ in. hand hoses equipped with fog nozzles.

The entire LPG installation is also protected by Creole's mobile fire-fighting units available in the Lake Maracaibo area for protection of all the company's facilities.

The plant site includes more than 80 acres to provide for future expansion of LPG production and storage facilities. Preliminary studies show that LPG production could be doubled when and if market conditions justify such an expansion. ★ ★ ★

Would a CO Boiler Pay Off in Your Plant?

These charts will help you figure the economics

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Stearns-Roger Manufacturing Company
Denver, Colorado

SINCE THE FIRST catalytic cracking units were installed, continuing efforts have been made to obtain maximum fuel economy by recovery of heat from the regenerator flue gas. The regenerator flue gas usually represents a large quantity of high temperature gas. It also contains varying amounts of combustibles and is available for discharge from the unit at a positive pressure. The flue gas stream therefore represents an ideal potential source of fuel economy. The processes for recovery are numerous. As in all such cases, there are one or two processes which prove to be least troublesome, most economical or least costly. The use of CO boilers is one of the means of recovering heat from catalytic cracking unit flue gas.

Advantages of CO Boilers

A CO boiler may provide several advantages. First is production steam for refinery use. Heat is available from heat of combustion of carbon monoxide and from sensible heat of regenerator flue gas. This advantage is the usual reason for installing a CO boiler. Second, the CO boiler may be used to eliminate or materially reduce the quantity of air pollutants discharged to the atmosphere. A CO boiler need not be confined to use with a catalytic cracking unit. Flue gas from a fluid coking unit may be even more attractive as a source of CO gas. Consideration in this article, however, is given to a CO boiler in its use in conjunction with a catalytic cracking unit only. Further, its justification is based solely on economic incentive derived from improvement in overall refinery thermal efficiency.

A CO boiler usually may be used in a specific refinery to improve overall energy balance. This assumes that refinery fuel is not or would not be flared or otherwise deliberately wasted. Installation of a CO boiler does not always improve the economic picture even though it might improve energy balance. There are minimum capacities, flue gas temperatures, fuel values, etc., which determine the economic desirability of a CO boiler for a specific refinery. Generalized correlations are presented here to help in defining these limits.

Design and Operation of CO Boilers

The CO boiler today is fairly standardized as to size for gas flow and steam production.[1] However, special needs may require custom design for a specific duty. In general, it is a vertical circular type boiler with a water cooled or refractory furnace. Both CO gas and supplementary fuel are fired tangentially into a firebox maintained at 1800 F minimum. Spent gases pass through a vortex at the top of the furnace and then over superheater sections. The gases then cross the convection pass of the boiler, pass through an economizer and up the stack.

CO gas can either be fired into the boiler unit or bypassed to the stack. The boiler can operate on 100 percent supplementary fuel when the source of CO gas is cut off.

Sootblowers, platforms, steel structures, instruments and controls, etc., are normally included. The boiler itself, however, does not contain an oxidation catalyst chamber for conversion of the carbon monoxide to carbon dioxide. It depends instead upon maintenance of a minimum 1800 F CO gas combustion temperature within the primary furnace section by introduction of supplementary fuel. Some supplementary fuel is always used to provide a source of ignition.

Justifying a CO Boiler

It is apparent that requirement for steam production is of paramount importance in evaluating a CO boiler. The poorest situation would be one in which the refinery has adequate steam gen-

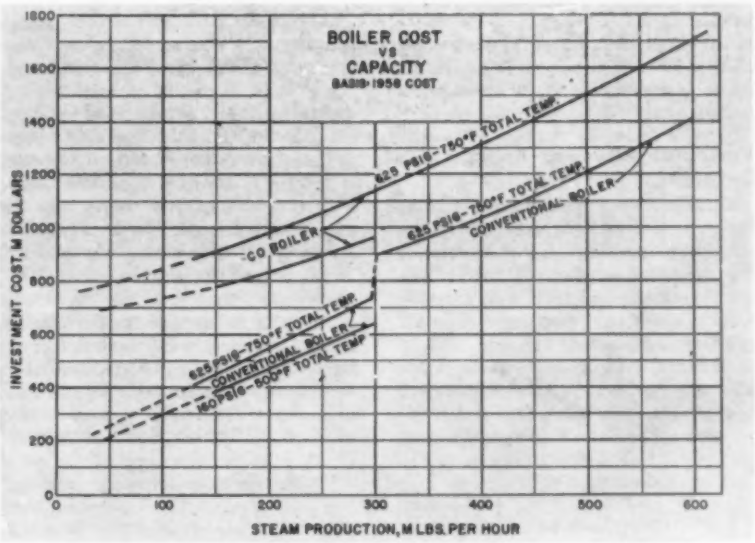

FIG. 1. This chart shows installed costs for both CO and conventional boilers. It can be used in calculating the return on incremental investment when using a CO boiler to provide additional steam capacity, rather than a conventional unit.

*Presented at the Western Petroleum Refiners Association Regional Meeting at El Paso, Texas, May 22, 1958.

1. For diagram of a typical CO boiler, see *The Refining* Engineer, February, 1957, page C-39.

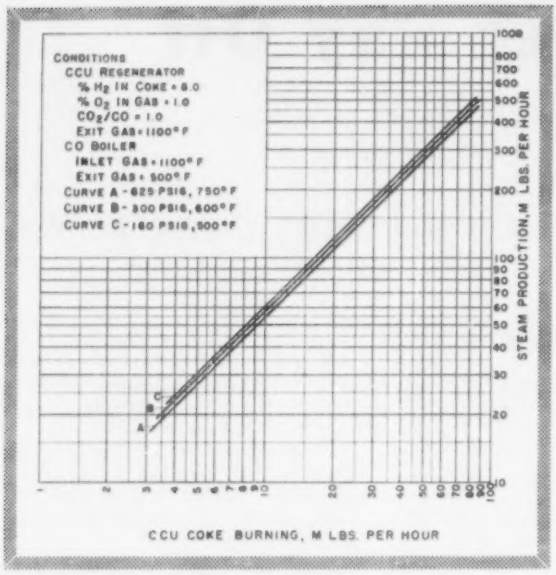
CONDITIONS
CCU REGENERATOR
% H2 IN COKE = 8.0
% O2 IN GAS = 1.0
CO2/CO = 1.0
EXIT GAS = 1100° F
CO BOILER
INLET GAS = 1100° F
EXIT GAS = 500° F
CURVE A - 625 PSIG, 750° F
CURVE B - 300 PSIG, 600° F
CURVE C - 160 PSIG, 500° F
STEAM PRODUCTION, M LBS. PER HOUR
CCU COKE BURNING, M LBS. PER HOUR

FIG. 2. Minimum steam production vs catalytic cracking unit coke burning rate is shown here. Coke burning rate is the primary independent variable in determining quantity and character of regenerator flue gas.

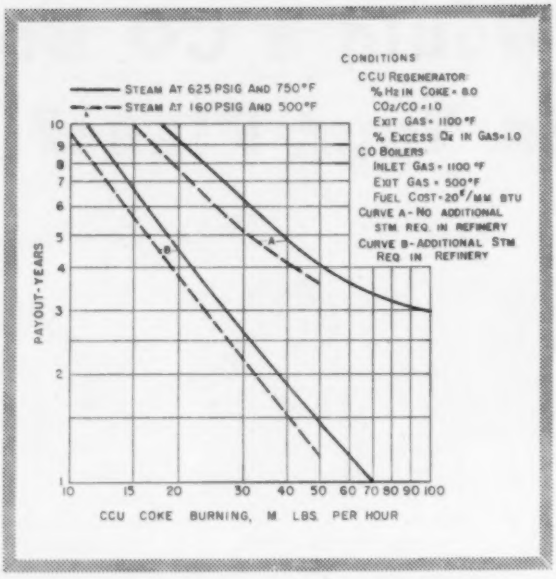
STEAM AT 625 PSIG AND 750°F
STEAM AT 160 PSIG AND 500°F
CONDITIONS
CCU REGENERATOR
% H2 IN COKE = 8.0
CO2/CO = 1.0
EXIT GAS = 1100 °F
% EXCESS O2 IN GAS = 1.0
CO BOILERS
INLET GAS = 1100 °F
EXIT GAS = 500°F
FUEL COST = 20¢/MM BTU
CURVE A - NO ADDITIONAL STM REQ. IN REFINERY
CURVE B - ADDITIONAL STM REQ. IN REFINERY
PAYOUT - YEARS
CCU COKE BURNING, M LBS. PER HOUR

FIG. 3. Payout for CO boilers as a function of catalytic cracker coke burning rate. Solid lines show the general case . . . here, minimum coke burning rate that would show reasonable payout is about 31,000 lb per hour. Dashed lines . . . for lower pressure steam . . . show a minimum coke burning rate of about 14,000 lb per hour for reasonable payout.

eration facilities and the CO boiler would simply retire existing operating equipment. Most advantageous economic situation would be one in which the refinery was in need of additional steam capacity. The CO boiler would then be installed instead of a conventional unit. The accompanying curves present the incentive for installing the CO boiler on both extreme situations, for a general case. All subsequent variations of the general case are based on the assumption that additional refinery steam capacity is required.

Fig. 1 permits calculation of differential cost of a CO boiler over a conventional boiler in determining equipment cost under the situation that additional steam generation facilities must be installed.

Variables Affecting Boiler Output

Catalytic cracking unit coke burning capacity is a fundamental factor in determining quantity and character of regenerator flue gas. All correlations are presented, therefore, with catalytic cracking unit coke burning rate as the primary independent variable.

Several simplifying assumptions have been necessary. Two of these are of interest at this point. One is that the regenerator-reactor heat balance does not affect CO boiler evaluation. The second assumption is that any one physical condition of the regenerator could be varied without affecting other conditions. Other variables affecting the CO boiler payout which have been investigated are: (1) CO_2/CO ratio, (2) Wt of hydrogen in coke, (3) Vol of excess oxygen in regenerator flue gas, (4) CO gas inlet temperature to CO boiler and (5) fuel value.

Normal variables which have been fixed in this study are: (1) Quench water to the regenerator, (2) stripping steam carryover and other sources of steam to regenerator, (3) CO boiler stack temperature and excess air, (4) CO boiler supplementary fuel character, (5) steam pressure and temperatures, (6) ambient air temperature and humidity and (7) continuous operation for 8000 hours per year.

All correlations are based on an assumed total source of extraneous steam and water to the cat cracker regenerator of 0.54 lb per lb of coke burned. CO boiler stack temperature has been fixed at 500 F with 2 percent excess oxygen in the flue gas; the CO boiler supplementary fuel was assumed to be methane; and the CO boiler was assumed to receive feedwater at 240 F. Ambient air temperature was assumed at 80 F and 50 percent relative humidity.

In order to simplify the correlations relating payout of CO boilers to coke burning capacity, a general case is presented in which the variables are fixed at assumed normal conditions. Effect of each variable is explored independently in subsequent correlations, while all other variables are held constant. For the general case operating variables have been fixed as follows: (1) Hydrogen in coke at 8.00 wt percent (2) excess oxygen in regenerator flue gas at 1.00 vol percent, (3) CO_2/CO ratio at 1.00, (4) CO gas inlet temperature to CO boiler at 1100 F, (5) a fuel value of 20 cents per million Btu normally consumed in conventional boilers at 85 percent efficiency, and (6) steam produced at 625 psig and 750 F. A second general correlation is presented with steam produced at 160 psig, and 500 F.

Charts Show Costs and Steam Production

Basic data on installed boiler costs, which have been used in all subsequent correlations are shown in Fig. 1. It presents a curve of boiler costs versus steam capacity for CO boilers and conventional boilers. Costs presented are for two steam pressures and temperatures, namely, 625 psig at 750 F and 160 psig at 500 F. Other steam pressures and temperatures can be used within reasonable limits. It should be noted that an abrupt change in the cost curve of the conventional high pressure boiler is indicated at approximately 300,000 lb per hr of steam capacity. This is due to a change in boiler design from a standardized production type for capacities up to about 300,000 lb per hr to a custom built unit of different design for higher capacities. Also, it may be seen that the low pressure curve does not go above 300,000 lb per hr. At capacities above 300,000 lb per hr higher pressure steam is invariably generated. As in all investment cost curves it must be recognized that an individual situation might deviate from the curves in either direction. It is primarily for this reason borderline situations must

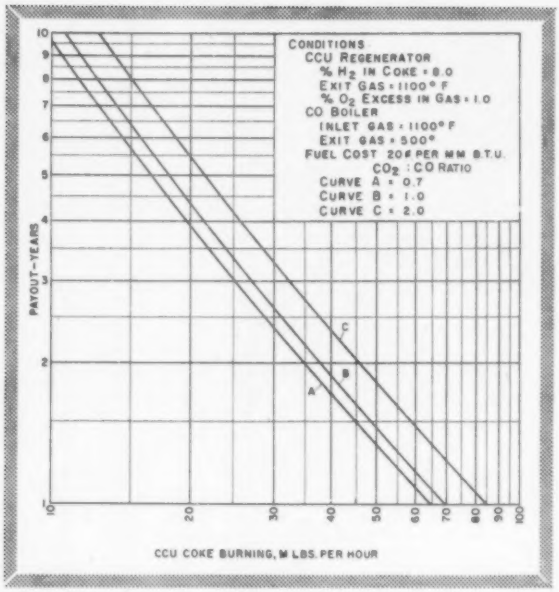
CONDITIONS
CCU REGENERATOR
% H_2 IN COKE = 8.0
EXIT GAS = 1100° F
% O_2 EXCESS IN GAS = 1.0
CO BOILER
INLET GAS = 1100° F
EXIT GAS = 500°
FUEL COST 20¢ PER MM B.T.U.
CO_2 : CO RATIO
CURVE A = 0.7
CURVE B = 1.0
CURVE C = 2.0
PAYOUT-YEARS
CCU COKE BURNING, M LBS. PER HOUR

FIG. 4. Effect of catalytic cracker CO_2/CO ratio on CO boiler payout is shown here. Curve B is the general case.

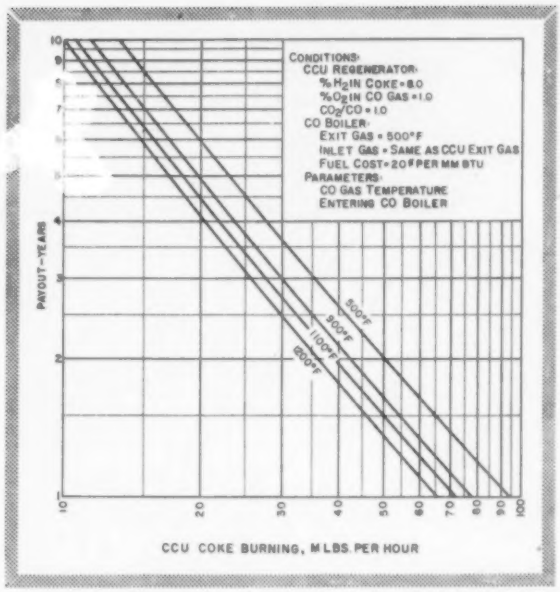

FIG. 5. Effect of regenerator flue gas temperature entering the CO boiler has some influence on payout, as shown in this chart.

be individually investigated.

Fig. 2 presents a correlation of coke burning rate versus CO boiler minimum steam production rate for the general case. Naturally, the CO boiler may be designed for any steam production rate above the minimum by use of additional supplementary fuel. Minimum steam production is the total steam produced by recovery of heat from: (1) Combustion of the carbon monoxide in CO gas, (2) the sensible heat in incoming CO gas and (3) combustion of any supplementary fuel.

In some instances there is sufficient heat in the CO gases to provide a calculated 1800 F temp without the use of supplementary fuel. However, to assure continuity of operation, some small amount, approximately 5 percent of total heat, should be fired at all times. Minimum steam production shown in Fig. 2 does not include supplementary firing. For the general case Fig. 2 is used to determine boiler costs from Fig. 1. A similar approach was used for all cases, but these data are not presented directly as minimum steam production figures.

Calculating Payout Periods

Payout periods shown in Fig. 3 through 7 are calculated for the assumed conditions as follows. A total heat absorption in CO boiler is calculated. Total heat absorption is reduced to net heat absorption from the CO gas stream by subtracting 85 percent of supplementary fuel heat released. This assumes that 85 percent represents the efficiency of utilization of supplementary fuel in a conventional boiler. Heat absorption attributable to the CO gas stream is then multiplied by the supplementary fuel value in a conventional boiler at 85 percent efficiency to obtain the annual value of CO gas as fuel. This CO gas value represents gross savings from the CO boiler installation. Cost of a CO boiler at minimum steam production is determined from Fig. 1. Cost of a conventional boiler of similar capacity is obtained from Fig. 1 and the differential cost of a CO boiler is determined by difference. Gross savings are reduced to gross profit by subtracting 12 percent of investment for annual maintenance, fixed costs and cost of capital. Annual depreciation was assumed to be 7 percent of investment. Net profit was computed after corporate taxes on net taxable income after depreciation. Gross income that was applied to pay out the boiler cost was then the sum of depreciation and net profit after taxes. No charge has been applied against the CO boilers for operating labor. The assumption has been made that in the event of either conventional or CO boiler installation the manpower requirements would be the same. Also, the assumption has been made that fuel saving will not force flaring of butane or refinery fuel. Payout of six years after taxes is assumed to be an attractive investment.

Fig. 3 presents the correlation of coke burning rate versus payout period for the aforementioned general case. Curve A shows the payout of a CO boiler in a refinery requiring no additional steam production capacity. Curve B shows the payout of a CO boiler in a refinery requiring additional steam capacity in the amount of the CO boiler capacity. From Fig. 3 one may see that the minimum size cat cracker that could pay out a CO boiler in six years has an approximate coke burning rate of 31,000 lb per hr. This depends on the fact that the refinery did not need additional CO boiler capacity of approximately 135,000 lb per hr of steam (625 psig and 750 F). In the event the refinery must otherwise install additional conventional boilers, the minimum size cat cracker that could pay out a CO boiler in six years has an approximate coke burning rate of 15,000 lb per hr. The resulting CO boiler could produce a minimum of 68,000 lb per hr of steam at 625 psig and 750 F.

Dashed lines in Fig. 3 are based on generated steam conditions of 160 psig and 500 F. Less expensive boilers result in a six-year payout for the CO boiler at 14,000 lb per hr coke burning rate for a refinery requiring at least 62,000 additional lb per hr of steam. In a refinery not requiring additional steam capacity, coke burning capacity required for six-year payout of CO boiler is 25,000 lb per hr.

Many cat cracker regenerators operate with a flue gas CO_2/CO ratio higher than 1.0. Fig. 4 presents a correlation showing the effect of variable CO_2/CO ratio on the payout period of Fig. 3. Curve B on Fig. 4 is the general case. These curves show that if the cat cracker in the general case is operating with a CO_2/CO ratio of 2.0 instead of 1.0 the required coke burning rate of the cat cracker, to pay out the incremental CO boiler cost in six years, is increased from 15,000 lb per hr to 18,500 lb per hr. In other words if the coke burning rate is 15,000 lb per hr the payout is eight years for a CO_2/CO ratio of 2.0 and six years for a CO_2/CO ratio of 1.0.

CO gas inlet temperature has a sig-

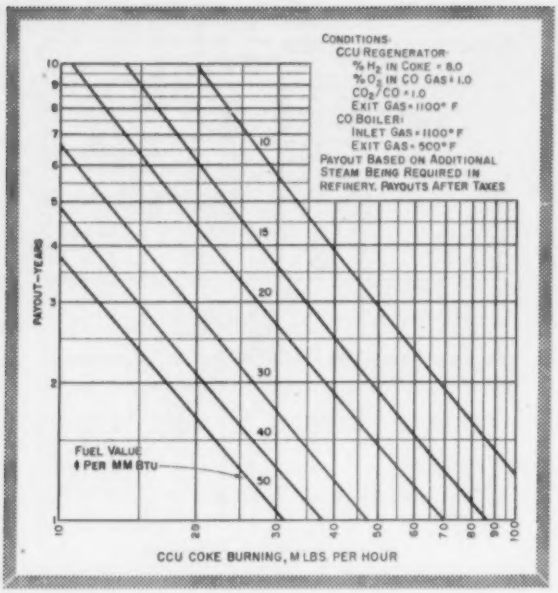

FIG. 6. This chart shows the effect of refinery fuel value on CO boiler payout, again as a function of coke burning rate. General case is figured at 20 cents per MM Btu.

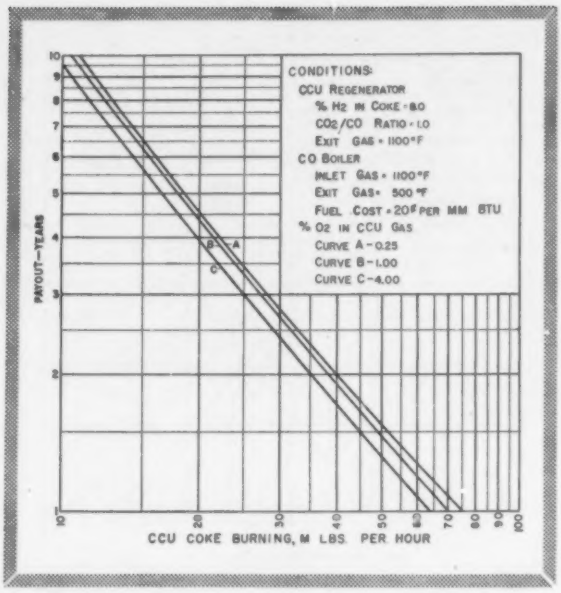

FIG. 7. Oxygen content in regenerator flue gas has some effect on CO boiler payout, as shown here. Curve B . . . one percent O_2 . . . is the general case.

nificant effect on CO boiler payout for a given coke burning rate. If a waste heat boiler on the regenerator flue gas is existing, practically no sensible heat from the gas can be obtained in the CO boiler. Additional fuel is then required to maintain the 1800 F combustion zone temperature. Fig. 5 shows the effect of variable CO gas inlet temperature on CO boiler payout as a function of coke burning capacity. If a waste heat boiler is already existing on a given catalytic cracking unit dictating a 500 F inlet gas temperature to the CO boiler, the coke burning rate required to pay out the CO boiler in six years is approximately 20,000 lb per hr. This is compared with the 15,000 lb per hr required for an inlet gas temperature of 1100 F. Assume CO gas is not cooled between the regenerator and the CO boiler. Then the normal range of temperature variation of the regenerator flue gas is not a significant factor in determining the incentive for installing a CO boiler.

Fuel value is a very significant factor in determining payout of a CO boiler. Fig. 6 shows the effect on CO boiler payout of varying fuel values from 10 to 50 cents per million Btu.

The effect of variable excess oxygen the regenerator flue gas on payout of a CO boiler is shown in Fig. 7. This effect is generally insignificant as shown by coke burning rates required. At six years payout and a maximum variation from 0.25 to 4.0 vol excess oxygen the required coke burning increases from 14,300 to 16,000 lb per hr.

The effect of variable hydrogen content of the coke was investigated and found to be insignificant. This lack of variation is explained as follows: As the weight percent hydrogen content of the coke is increased at constant coke burning rate and at constant CO_2/CO ratio, the CO production decreases. But at the same time the total mass of regenerator flue gas increases by large proportions, since one pound hydrogen requires roughly six times the weight of air for combustion that one pound of carbon requires to form carbon monoxide. The resulting increase in available sensible heat at a fixed temperature offsets the decreased CO heat of combustion.

Summary

Economics of a CO boiler installation in conjunction with a catalytic cracking unit are specific for a given refinery. However, the economics may be generalized sufficiently to determine a range of catalytic cracking unit sizes which can pay out a CO boiler. The basic variable used in determining the size is coke burning. Many other operating variables affect the incentive for installing a CO boiler. However, these variables have been reduced to a minimum number and their general effect on CO boiler payout determined. Variables which affect payout other than catalytic cracking unit capacity are presented in order of decreasing importance as follows: (1) Fuel value, (2) CO_2/CO ratio, (3) flue gas temperature, (4) excess oxygen in CO gas and (5) hydrogen content of regenerator coke.

The accompanying charts present generalized payout curves for CO boilers as a function of a cat cracker's coke burning rate. Assuming additional steam is required, a coke burning rate of 11,000 lb per hr or more can be attractive for installation of a CO boiler when the fuel has a value of 20 cents per million Btu. If additional steam is not required, the minimum coke burning rate to provide a reasonable payout for a CO boiler is about 18,000 lb per hr. When the coke burning rate is much below this range there is little economic incentive to investigate a CO boiler unless the refiner desires to minimize the auxiliaries.

It should be remembered that in addition to the above, other factors may be significant. High water content in the flue gas could improve the payout. In some areas reduction in noxious fumes may be sufficiently important to justify payout longer than six years. Operating experience on about ten CO boiler units indicates that 5 to 10 percent more steam is produced from CO gas than would be calculated. This is a result of entrained hydrocarbons which do not show up in normal CO gas analysis.

Although the CO boiler is not a panacea in all plants, it may be a moneymaker for you. Check the charts and decide for yourself if your plant can afford to be without a CO boiler.

Acknowledgment

The authors wish to express their appreciation to Babcock and Wilcox Company and The Stearns-Roger Manufacturing Company for their aid in preparing this report and for permission to publish it. ★ ★ ★

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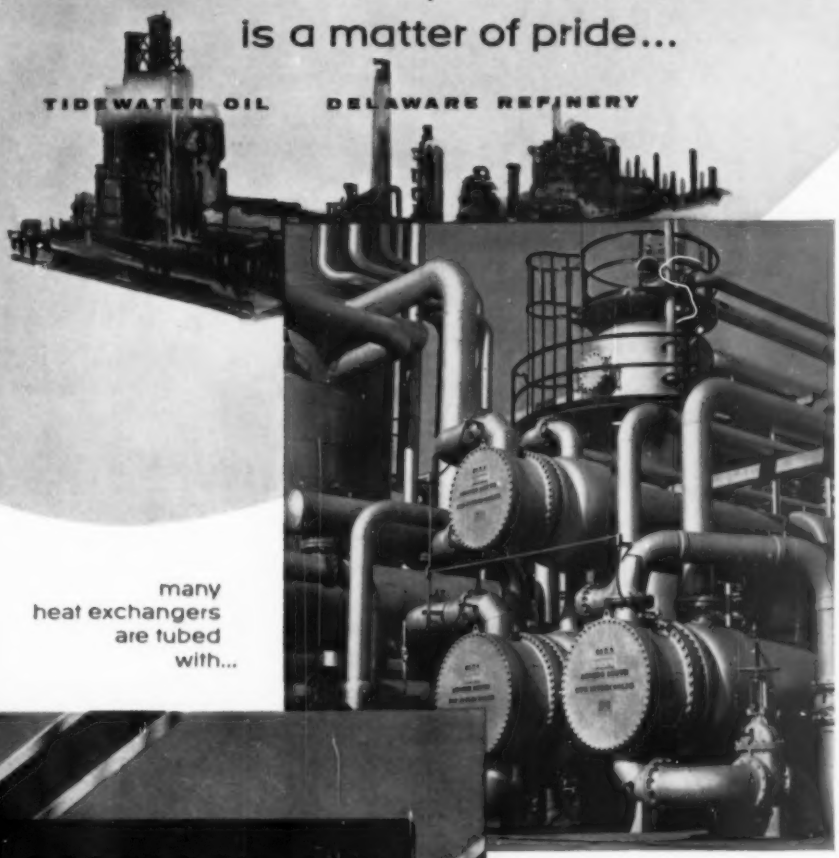

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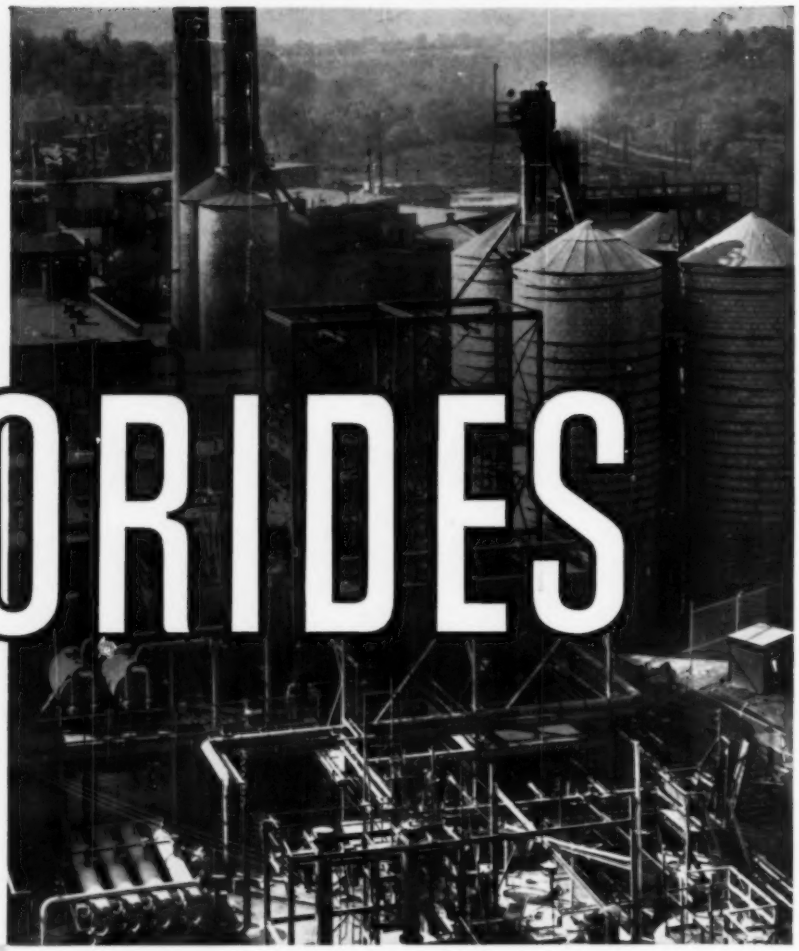

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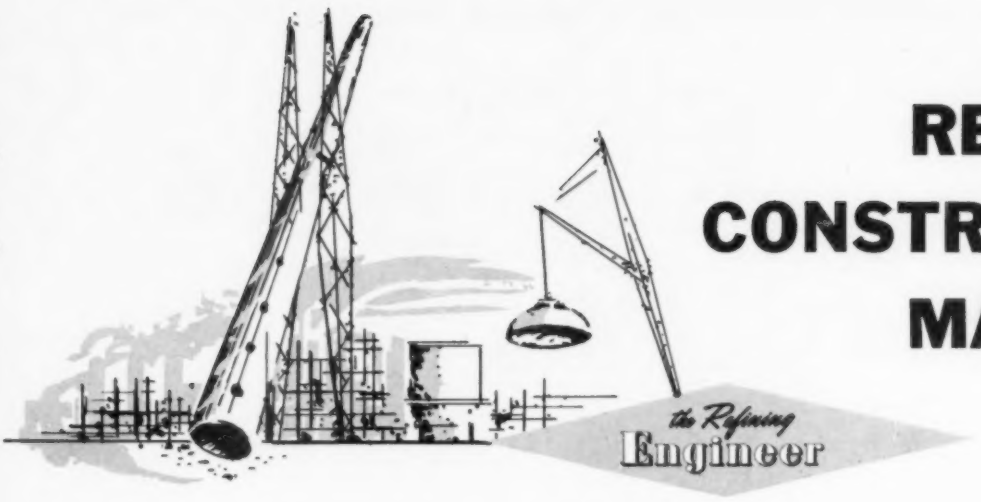


REFINERY CONSTRUCTION MANUAL

Henry Martyn Noel
New Canaan, Connecticut

Part 2: Engineering the New Refining Unit . . .

. . . Planning — Estimating — Scheduling

. . . Process and Mechanical Design

. . . Drafting — Procurement

IN LARGE OIL COMPANIES and refinery engineering-construction companies, frequently having 10 to 30 projects proceeding simultaneously, "office engineering" work is generally seen in all of its various stages of development.

By long experience, and because of competition, these large companies have brought office engineering to a very efficient cost level. Considering competition among major engineering and construction companies, their estimating work must be very comprehensive, especially to develop a firm bid on a turnkey job — taking about three months longer than a similar bid on cost-plus fixed-fee basis.

Office engineering has many phases, including economic studies, process planning, estimating, scheduling, process and mechanical designs, drafting and procurement. Also included may be materials and equipment testing, process laboratory work, inspection in fabricators' shops, testing of new refinery units upon completion, and start-up advisory groups in liaison with the client.

While engineering organizations with many jobs going at the same time tend to have separate departments for each of the office engineering phases, it is not unusual for oil companies to use separate engineering task forces. These task force groups each do the planning, designing, estimating, procurement, and even drafting supervision for all phases of a given project.

Although total time input for all phases of office engineering may be only 20,000 manhours for a pipestill, or only 200,000 for a small complete fuels refinery (no lubes), calendar time for this work is often as great as the period of actual construction. However, though most of the design engineering is done before construction starts, much of the drafting and procurement work overlaps construction.

Note that for new and unproved processes on which there is no background of design data, a period of from several months to several years of process development might intervene before commercial design work can start.

Preliminary consideration work for the refinery construction project (discussed in Part 1, *The Refining Engineer*, June 1958, pages C-11-13) is not included in the following summary of office engineering. Recognized, though, this frequently involves considerable engineering time for economic and process studies.

Planning-Estimating-Scheduling — Summary

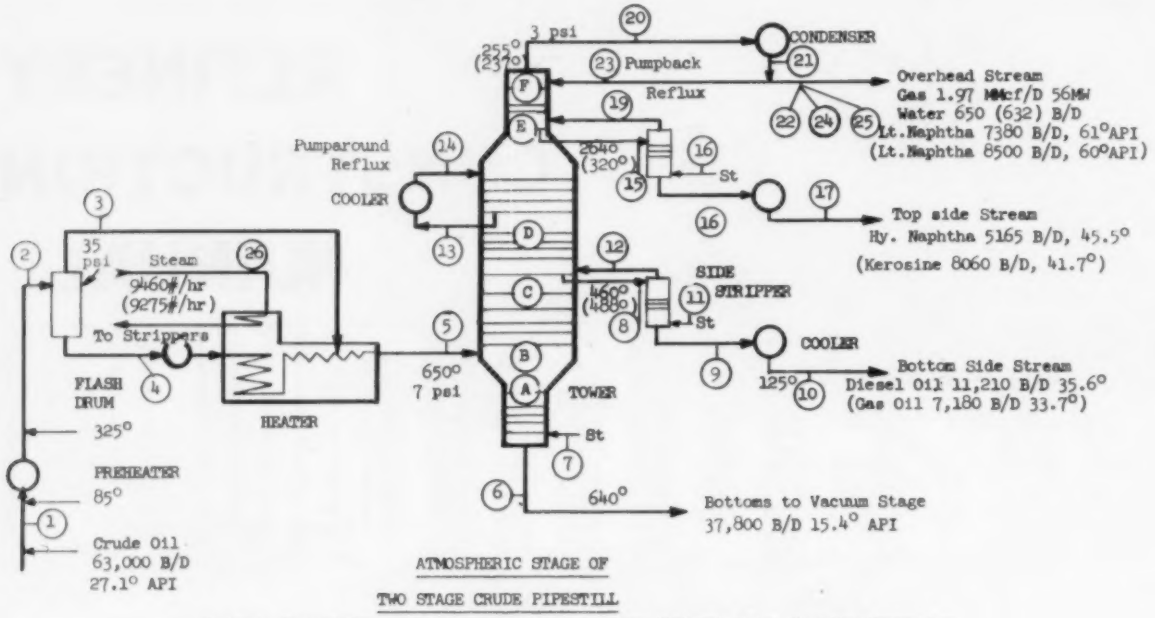
Process information memorandum. Following economic studies and comparison of various alternatives — using approximate designs and rough estimates for analysis — a definitive process information memorandum . . . commonly called a PIM . . . is prepared.

This PIM is the first part or stage of the Project Specification, and may require 15 pages — about 10 percent of all the material needed to specify a new catalytic cracker. It formulates the basis of all following engineering work — setting forth plans on equipment sizing and type, catalysts, and (frequently) rough heat and material balances and a schematic flow plan.

Preparation might take 6 men less than a month for a simple pipestill, while a complete refinery — needing several such PIM's — would take 12 to 15 men 3 to 4 months. A process flow plan that would be in such a memo is shown in accompanying chart.

Procurement engineers may be able to write advance *preliminary* requisitions for piping, tankage, and structural and reinforcing steel after the first few weeks of basic work on the first memos. They can also warn potential suppliers of impending orders for vessels, compressors, switchgear and other long delivery-time items.

Definite estimating can usually start immediately with the process memos, since the estimators are familiar with



Notes: Quantities outside parentheses are for 300 End Point Naphtha Operation
Quantities inside parentheses are for kerosine operation. Equipment designed with flexibility indicated will be suitable for other operations.
Figures in circles refer to items in "Heat and Material Balance" sheet.
Letters in circles refer to items in "Tower Loading" table.

Schematic Process Flow Plan, including feed and yield quantities. Such a flow plan is usually included in the Process Information Memorandum.

the preliminary project considerations. Estimating for a complete refinery may take 4 to 6 men six months' time; it is done concurrently with design work.

Manhours for estimating can vary from 400 on a standard pipestill up to 4000 for a small, complete fuel products refinery. When in a rush, 5 men can estimate a simple unit in 2 weeks, while 8 men can estimate an entire refinery in about 3 months.

Scheduling work covers both engineering and field operations, also plans for time used in shop fabrication and delivery of purchased equipment. The work is also concurrent with estimating, but uses somewhat fewer manhours. Estimating may be done by a special group in the case of large contractors, and by project engineers — or an estimating group — in the case of oil companies.

Process and Mechanical Design

Process and mechanical design — not including drafting — consumes nearly 20 percent of the total engineering manhours on a project. This work takes less than 4000 manhours for a 2-stage pipestill, about 40,000 hours for a complete non-complex refinery.

For example, in an engineering company with, say, 80 men in the process and mechanical design groups, all engineering work for a simple unit excluding follow-up would be essentially complete 2 to 3 months after receiving the first part of the Project Specification — the Process Information Memorandum. In such a case, no more than 8 to 10 men would be used.

A complete refinery would occupy at least 20 process and mechanical design men,(some being active on just one project for at least 12 months. Major activity is, of course, during the first 6 months after receipt of the process memo.

About 60 percent of the design engineers' time is used in preparation of the detailed design specifications, used to guide draftsmen and procurement people for a small, complete fuel products refinery. There would be only 2 to 3 sets of design specifications for a simple pipestill, 3 to 4 for a catalytic cracker, and 20 to 30 for a complete refinery. Each design specification "book" averages 900 engineering manhours.

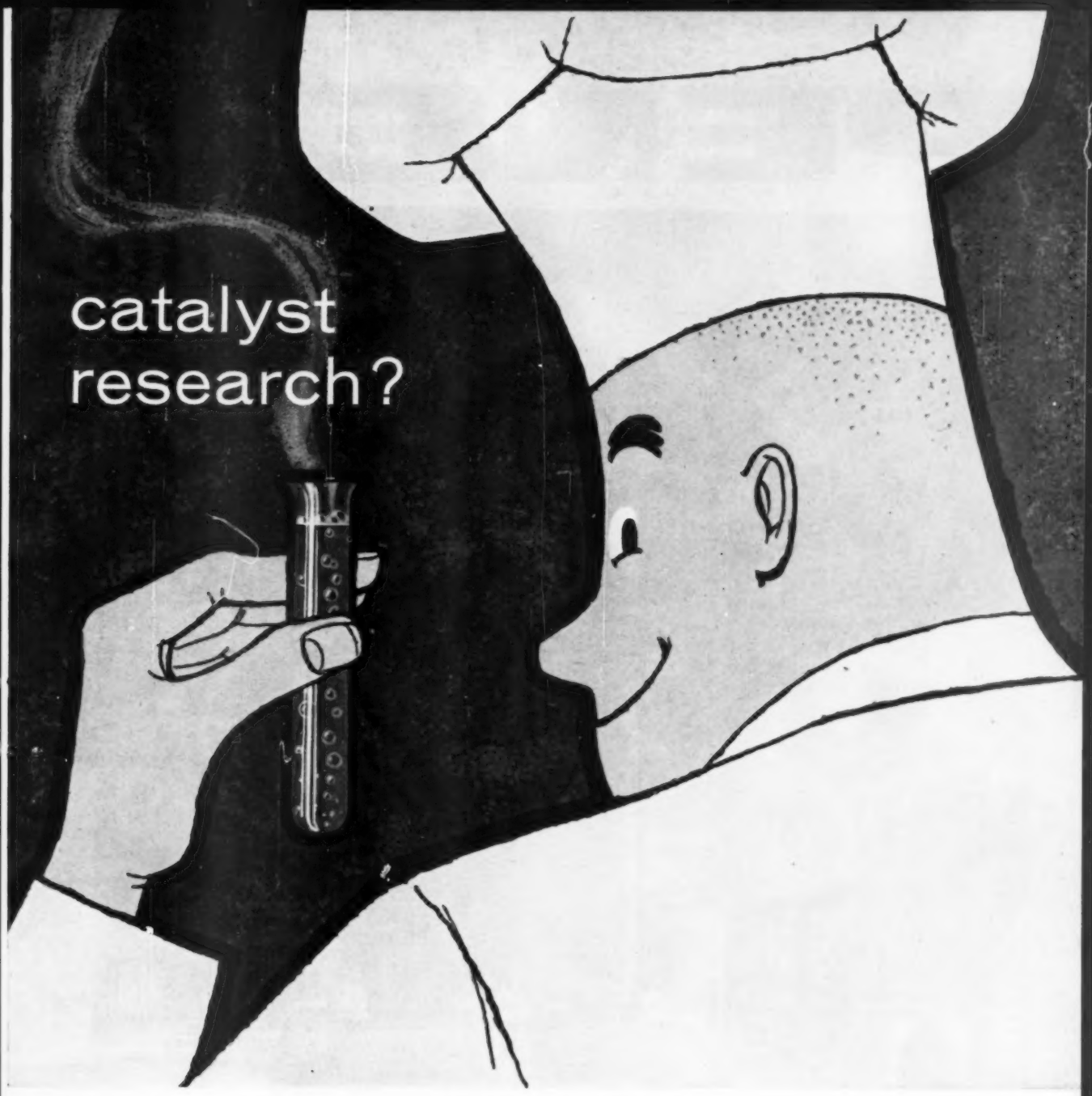
Operating manual preparation uses considerable process and mechanical design group time. Still another time-consumer for these groups is "trouble shooting" and assisting in new equipment startup.

Drafting

In a typical 100-man drafting staff — on occasion supplemented by up to 200 draftsmen from commercial drafting or engineering staffs — 50 men might work at the same time during early stages of a large assignment. Even for a simple still needing 100 drawings, 4 to 5 men would be needed to continue drafting for a total of about 10 months.

Drafting proceeds for at least a year for a catalytic cracker. A complete small refinery without lube equipment requires about 1000 drawings during an 18-month period. Each drawing uses 75 to 150 manhours, including supervision. Thus, total drafting manhours for a small complete fuels refinery would be more than 100,000.

In one large company, draftsmen do little or no designing,



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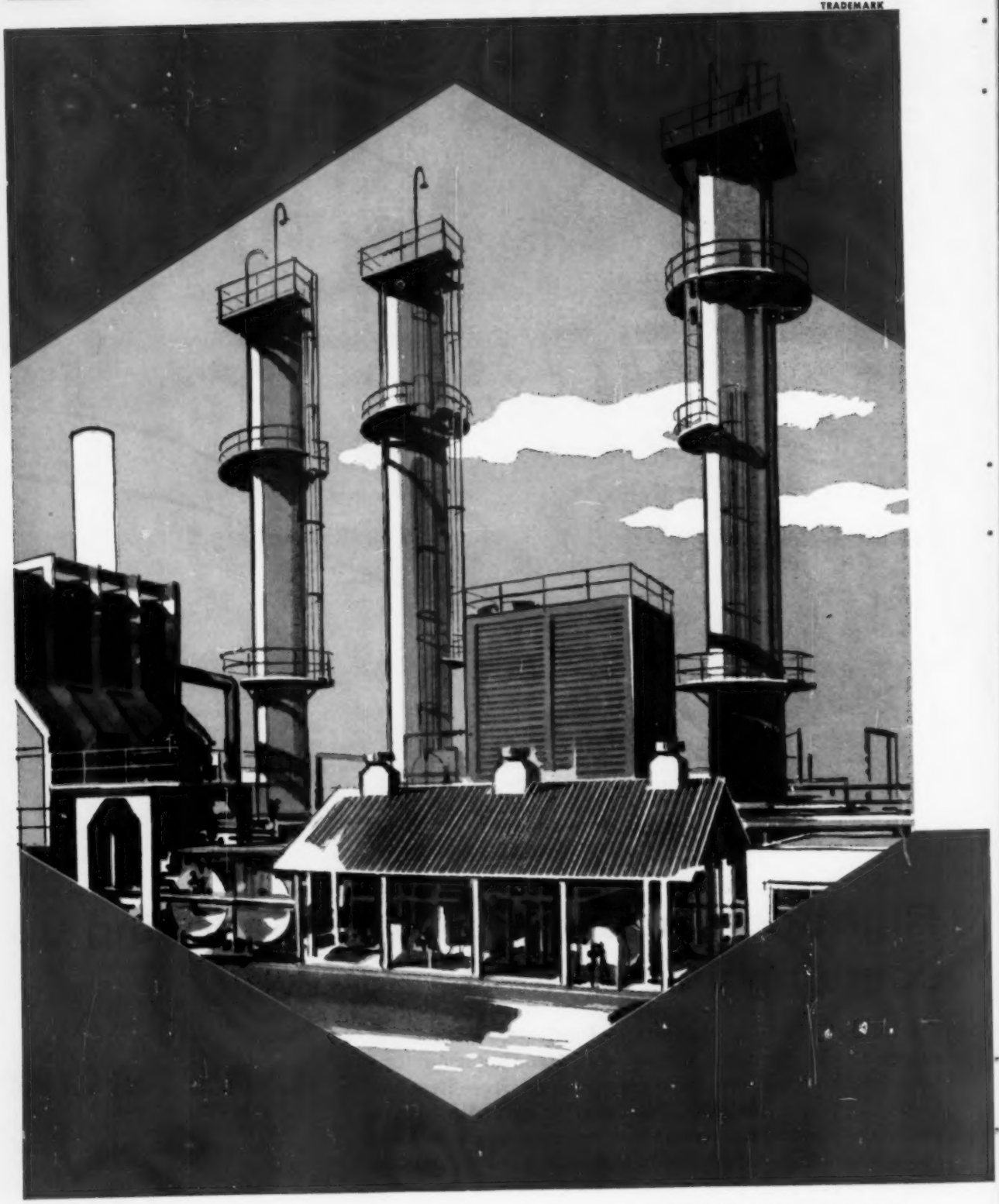

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Penex is the only commercial hydroisomerization process in operation. Here is how it works. Through the continuous catalytic isomerization of normal pentane and normal hexane in lower-value fuels, it produces a high octane isoparaffinic blending component. When blended with the fuel this component gives a finished product of higher octane value and superior combustion and carburetion qualities.

The Penex-produced finished product has high volatility, better burning qualities without plug-fouling and pre-ignition, better sensitivity and better lead susceptibility. The Penex method of increasing octane number with isoparaffins results in overall better-balanced, more efficient fuel.

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Refiners interested in improving lower-value fuels, in octane number and efficiency, are invited to investigate thoroughly the application of PENEX to their operation.

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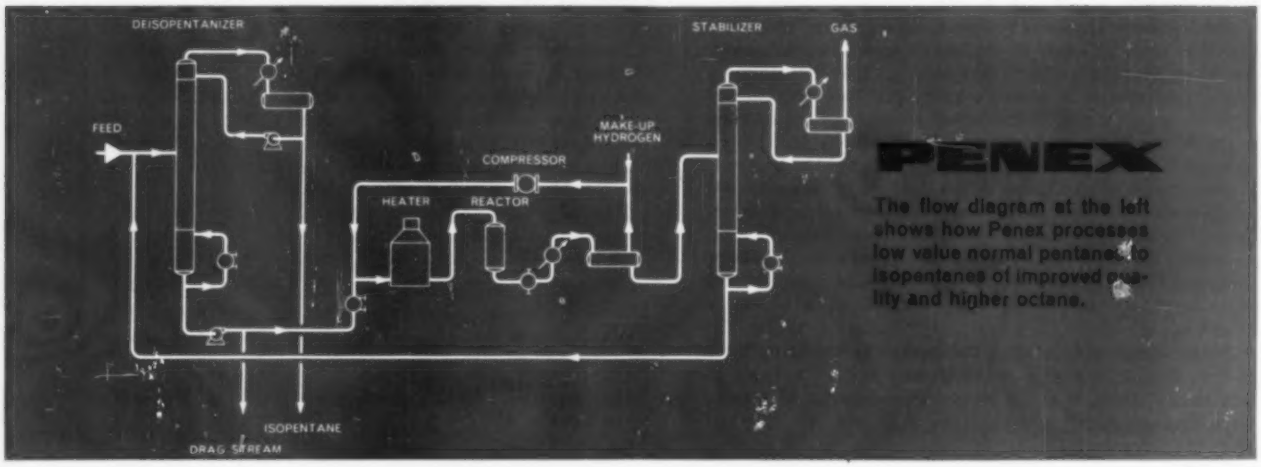

PENEX

The flow diagram at the left shows how Penex processes low value normal pentanes to isopentanes of improved quality and higher octane.

AVERAGE ENGINEERING TIMES FOR TYPICAL REFINERY PROJECTS.

	Simple 15,000 BPD Pipestill			15,000 BPD Fluid Catalytic Cracker			25,000 BPD Refinery[3]		
	Manhours[1]	Men at Peak	Months Covered[2]	Manhours[1]	Men at Peak	Months Covered[2]	Manhours[1]	Men at Peak	Months Covered[2]
PLANNING	1,500	6	1 (1)	3,000	6	6 (1-6)	11,000	20	6 (1-6)
Process study	400	4	1 (1)	800	4	4 (1-4)	3,500	12	3 (1-3)
Process memoranda	(1) 400	6	1 (1)	(2) 800	6	4 (1-4)	(9) 3,500	12	3 (1-3)
Estimating	400	3	1 (1)	800	3	5 (2-6)	2,500	6	5 (2-6)
Scheduling	300	2	1 (1)	600	2	4 (2-5)	1,500	5	4 (2-5)
DESIGN	2,800	10	8 (2-9)	5,000	12	14 (2-15)	37,000	25	12 (2-13)
Specifications	(2) 1,800	10	2 (2-3)	(3) 3,000	12	7 (2-8)	(25) 23,000	20	12 (2-13)
Follow-up	800	6	6 (4-9)	1,600	6	9 (7-15)	12,000	10	7 (7-13)
Standards	200	1	—	400	1	1	2,000	2	—
DRAFTING	10,200	25	9 (2-10)	21,000	30	14 (3-16)	102,000	52	18 (3-20)
Drawings	(100) 10,000	25	9 (2-10)	(200) 20,000	30	14 (3-16)	(1000) 100,000	50	18 (3-20)
Follow-up and standards	200	2	5 (6-10)	1,000	4	—	2,000	2	10 (11-20)
PROCUREMENT	5,500	12	9 (2-10)	17,000	18	14 (3-16)	50,000	31	18 (3-20)
Requisitions	(100) 4,000	12	9 (2-10)	(250) 10,000	18	14 (3-16)	(1000) 40,000	30	18 (3-20)
Follow-up	1,300	4	5 (6-10)	6,000	6	10 (7-16)	13,000	10	10 (11-20)
Standards	200	1	—	1,000	1	—	2,000	1	—
GRAND TOTALS	20,000	45	10 (1-10)	46,000	60	18 (1-18)	200,000	100	20 (1-20)

1. Numbers in parentheses indicate number of memos, specifications, drawings and requisitions.
2. Month serial numbers after D-day — "decision to build-day" — are shown in parentheses.
3. Refinery with thermal cracking, but without catalytic cracking or lube oil facilities.

only making drawings from sketches done by project engineers and/or assembled from certain standard parts drawings already on file. In other organizations, draftsmen are taught how to handle certain simple, routine design procedures.

Specialized refinery construction organizations have developed sets of drafting standards that expedite drawing production. Their experience and use of short-cut methods promotes rapid drafting.

Actual drafting does not begin until the pertinent process memo is issued, commonly starting before process and mechanical design specifications are complete. Drafting overlaps preparation of design specifications by 1 to 2 months for single units, and many months for a complete refinery — time used depending upon the number of specifications issued by the design groups.

Procurement

Procurement activities progress during about the same period as drafting work. Procurement goes on continuously for many months — rarely less than a year for a simple unit — and results in about as many purchase requisitions as there are drawings. While actual issuance of requisitions might be completed in 5 to 6 months for simple units, there is always follow-up work to be done afterward.

One case on record shows an expenditure of about 55,000 manhours over a period of 2 years for a complete fuels refinery. For a peak period of 3 months, 20 men were engaged.

Usually there are numerous regular forms and volumes of standards which relieve procurement men of much of the paper work, calculation and study that would be necessary otherwise.

Procurement work during the period indicated includes review of manufacturers' drawings and inspection work in fabricators' shops. It often takes only one week to write a large requisition after design specifications are received from the designers.

In one large oil company, the same engineers who prepare the designs also prepare the requisitions. It takes a month to get manufacturers' quotations through the purchasing department, plus a week to select a supplier. It then takes another month to secure and approve manufacturers' drawings.

Shopwork cannot start on equipment such as vessels and switchgear until 2 to 3 months after writing the requisition. There may be more delay waiting for a place on the shop's schedule. Typical lead times — total time from order to delivery — will be discussed in Part 8 of the Refinery Construction Manual, to appear in a future issue of *The Refining Engineer*. Throughout this lead time period, shop inspection by procurement men might be dictated.* Due to follow-up work by procurement men, procurement time is fully half that of drafting hours.

Limits of This Discussion

The preceding does not include functions and time used in preliminary studies, as mentioned before. Data in the table showing Typical Engineering Times do not reflect time in office administration, clerical, stenographic and service work, which may add up to 3 to 4 percent of total engineering work. Likewise, time is not included for the coordinating or project engineer, who is concerned with construction and client relations as well as with engineering.

Typical engineering times shown in the table are rough averages of a large number of cases. They may be high for cases where the job duplicates a previous job, or low — perhaps by one half — where complicated jobs or new designs are involved.

*For scope that inspection work by procurement engineers can take, see "Engineers in Purchasing Department" *The Refining Engineer*, March 1957, page C-6.

Next month, *The Refinery Construction Manual's* third chapter will discuss "Process and Mechanical Design Economics."

MODERN GASOLINE PLANTS

Part 3. Conventional Absorption in Small and Multi-Product Plants

Dave Vondy
Constructive Engineering Company, New Orleans, Louisiana

PLANTS INCORPORATING ABSORPTION at near-atmospheric temperature — termed conventional absorption here — and pressures from near-atmospheric to over 2500 psi find wide application. Conventional absorption is the most economical scheme of processing under many circumstances.

A great number of these plants have been installed and nearly every possible scheme of processing has been tried. New plants thus incorporate many years of broad experience gained by the industry.

Small Plants

The large amount of auxiliary equipment used in a large plant cannot be justified in a small operation. For example, elaborate schemes of reabsorption are seldom justified. The minimum facilities necessary for continuous operation should be considered. Utility requirements should be kept to a minimum, and complicated equipment which would require a specialist for repair or maintenance should be avoided.

One product plant. The small, single product plant scheme in Fig. 17 utilizes recycle rather than fractionation to reduce the absorbed light ends to a suitable liquid product. Gas flashed from the rich oil is used as stripping gas for the still eliminating the need for steam. Rich oil is preheated and fed to the still and the flash gas off the product is recycled to the absorber.

Since compression facilities are required for recycle, usual application of this scheme is in a situation where it is already necessary to compress the gas to be processed. For example, compression is required when low-pressure tail gas from oil production is used for gas lift.

Since recycle to an absorber will not be very effective at high pressure, the scheme is generally applied only at relatively low pressures.

Two products plant. A small two-product plant is illustrated in Fig. 18. Recycle is used to remove light ends from the products. Rich oil is flashed at near still pressure; this flash gas and uncondensed vapors from the still are recycled to the absorber. A closed steam generation system furnishes stripping steam without use of a boiler.

Hot lean oil from the still is used to generate steam and to heat the bottom of the fractionating column. Any additional heat is recovered by transfer to the rich oil. The split oil-to-oil heat exchanger allows a maximum temperature difference to be maintained, reducing required exchanger surface. It also provides a desirable control point for automatic distribution of the oil on demand.

Selection of flow pattern. The lightest product from a simple recycle plant will usually contain undesirable light fractions, perhaps influencing the decision on which process scheme is to be used. For example, even small excesses of lighter ends flowed to storage in any product will be vented causing loss in recovery.

As shown in Fig. 18, the recycle stream is introduced into the bottom of the absorber while the rich gas can be fed in a few trays from the bottom. Ethane and propane will normally build up in the recycle stream but there will be less of the undesirable methane if the equilibrium constant for ethane is appreciably higher than 1.0. If this equilibrium constant is not much higher than 1.0, an uneconomically high recycle would develop. If fixed compression facilities were in use, however, they could be fully loaded to realize maximum utility.

A recycle stream requires time to build up and stabilize; a recycle system can thus be expected to show better results when operating conditions are fairly constant than when changing.

Multi-Product Plant

The absorption section of a multi-product plant is illustrated in Fig. 19. Rich oil is flashed ahead of a deethanizer-reabsorber, vapors introduced below the reabsorption section, and the heated rich oil fed to the top of the deethanizer section. Rich oil is flashed ahead of the still and then heated by a preheater. Condensed still overhead is charged to required fractionation facilities. A closed steam regeneration system is shown.

Flashing feed ahead of the demethanizer results in a lower temperature in the reabsorption section, increasing the fractionation efficiency.

Use of a reabsorber-deethanizer eliminates excessive undesirable light ends in the lightest product and eliminates recycle which may have a high operating cost. It also increases product recovery and makes available fuel gas at a relatively low pressure.

This column is generally operated at a sufficiently low pressure to enable thorough deethanization. However, care must be taken in application and operation to avoid excessive lean oil requirement.

Such a column is necessarily tall and expensive to install, but is usually justified by the advantages, except in small plants.

High-Pressure Absorption

In locations where gas is to be reinjected into a high-pressure reservoir, it is desirable to carry out absorption at high pressure to minimize the initial and operating costs of compressor facilities. In addition to natural gasoline and lighter products, these cycling plants usually recover a considerable amount of a heavy-end product.

A process flow plan which has been found practical for

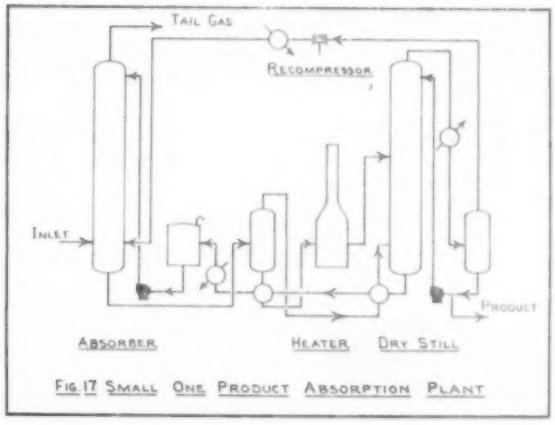

FIG 17 SMALL ONE PRODUCT ABSORPTION PLANT

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advantages of the TRETOLITE DESALTING SYSTEM

- *Proved Performer.*
  Used to purify 1½ million barrels every day.
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- *Automatic Operation.*

Tretolite desalting, the first all-chemical desalting process, is now available to you in a choice of plans, one of which is certain to fit into your operation and financial policies:

1 Standard Proposal

The Tretolite Company furnishes a list of the equipment required, instructions for installation and, working drawings, designed to tie in with the flow stream in the customer's refinery. Data on the rate of Tretolite injection for optimum desalting results, operating instructions, temperatures, pressures and water requirements are also included. Tretolite Refinery Service Engineers check construction procedure to insure that installation is according to specifications; they also assist with start-up and make periodic visits after the unit is in regular operation.

2 Outright Purchase

The Tretolite Company ships the desalting plant equipment to the refinery. Erection is then carried on by refinery personnel or by an erector of the customer's choice. Inspections during construction, start-up assistance, and periodic inspections are provided by the Tretolite Refinery Service staff as in plan No. 1. When the desalting plant is ready to go on stream, Tretolite Refinery Service Engineers supervise an acceptance test run to meet the guarantee of minimum chemical requirements and salt removal efficiency as set forth in the contract.

3 Rental with Option to Purchase

The rental plan is similar in all general respects as to instructions, supervision and materials furnished in plans No. 1 and No. 2. After acceptance requirements have been fulfilled, the pre-determined annual rental fee is payable according to the payment option selected by the customer.

After the plant has been operated for three years on the rental basis, the customer has the option of purchasing the equipment for a pre-determined price. (This price is reduced after each year's rental.) After a unit has been used on a rental basis for seven years, the annual rental fee is reduced about 50%.

For additional information,

ASK THE MAN IN THE RED CAR

Your Tretolite Refinery Service Engineer will gladly give you complete information on the various ways of acquiring Tretolite Desalting equipment, as well as operating and performance data on plants currently in service.

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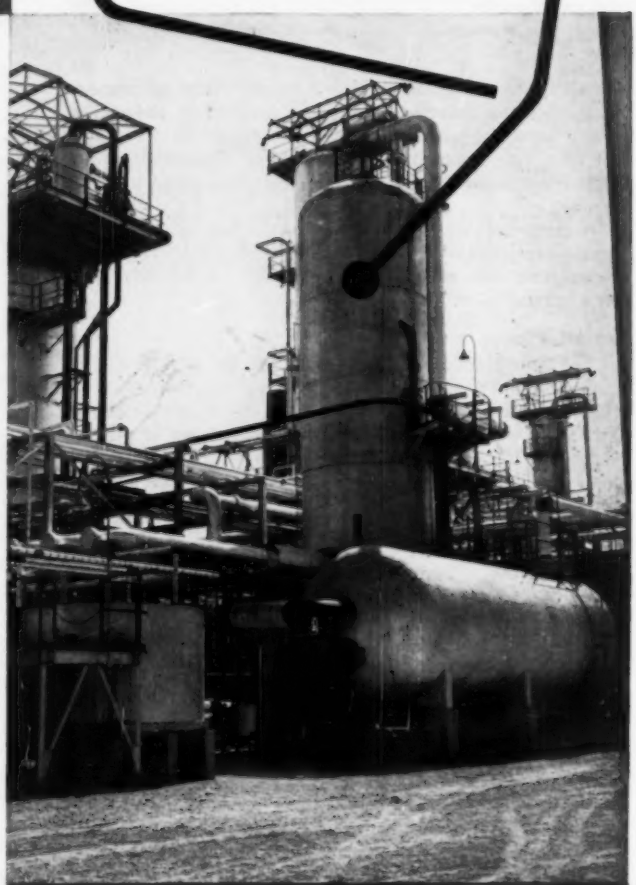

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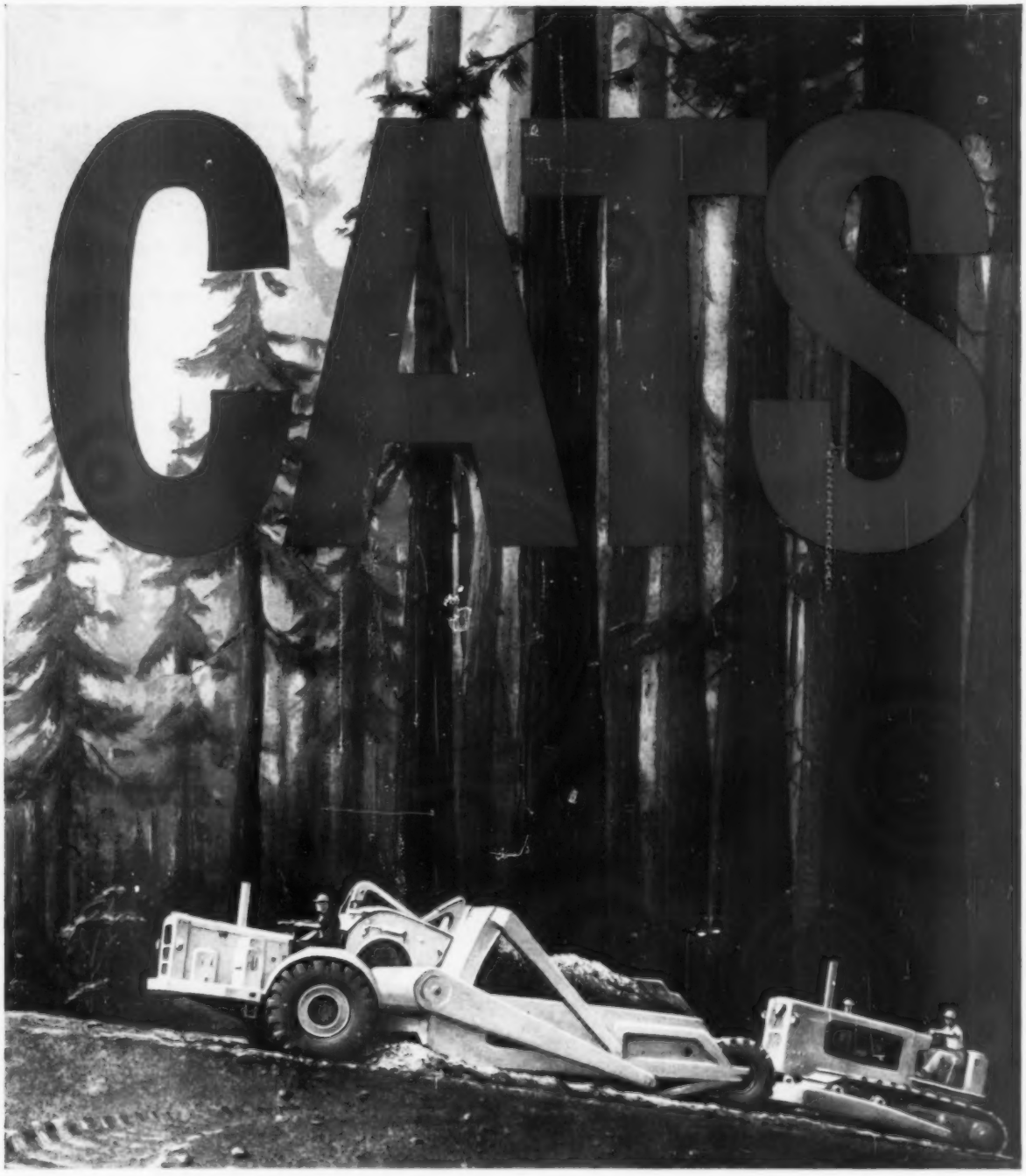

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absorption at pressure exceeding 2000 psi is illustrated in Fig. 20. Demethanization is carried out at a relatively high pressure with a stream (primarily ethane and propane) built-up and recycled to the demethanizer. A deethanizer is used ahead of the product fractionation facilities to enable production of a commercial propane.

When an appreciable amount of heavy distillate is removed as a side stream product from the lean oil, the circulated oil will generally be kept free of contaminating heavy residual. Otherwise, it may be necessary to remove a heavy product by stripping a small amount of the lean oil from the bottom of the still as shown in Fig. 20.

An alternate system of removing ethane from the rich oil is shown in Fig. 21. Such a non-refluxed column will enable removal of ethane with less equipment and often have lower installed and operating costs than will other techniques. This is especially true if there is adequate heat available in the rich oil from the still to heat the demethanizer and the deethanizer.

Loss from such a column fed by hot material from the

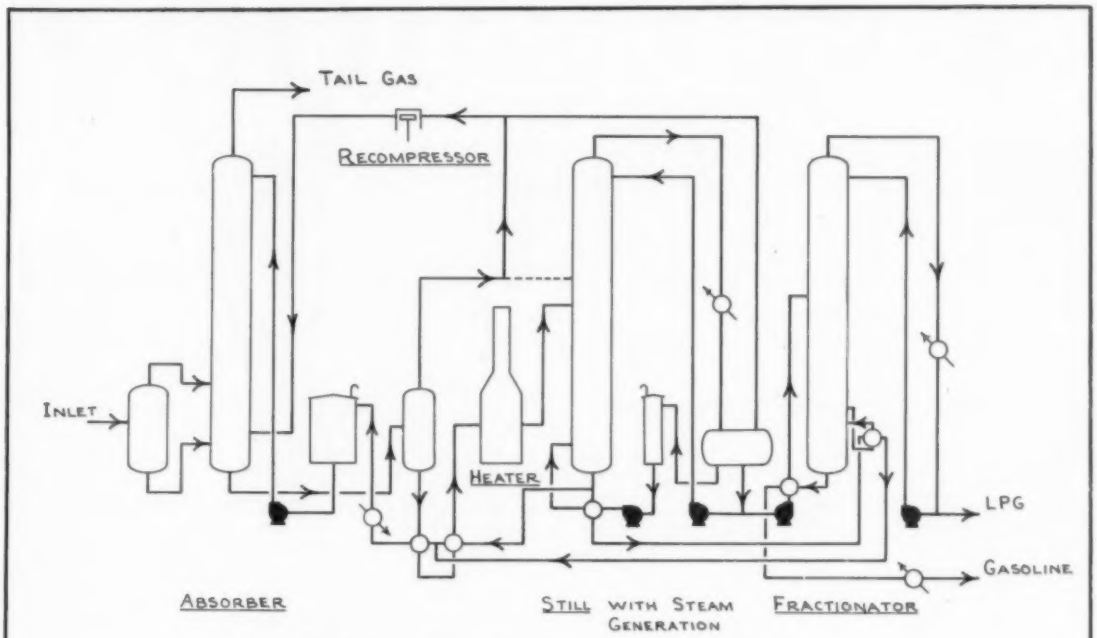

FIG. 18. SMALL TWO PRODUCT ABSORPTION PLANT

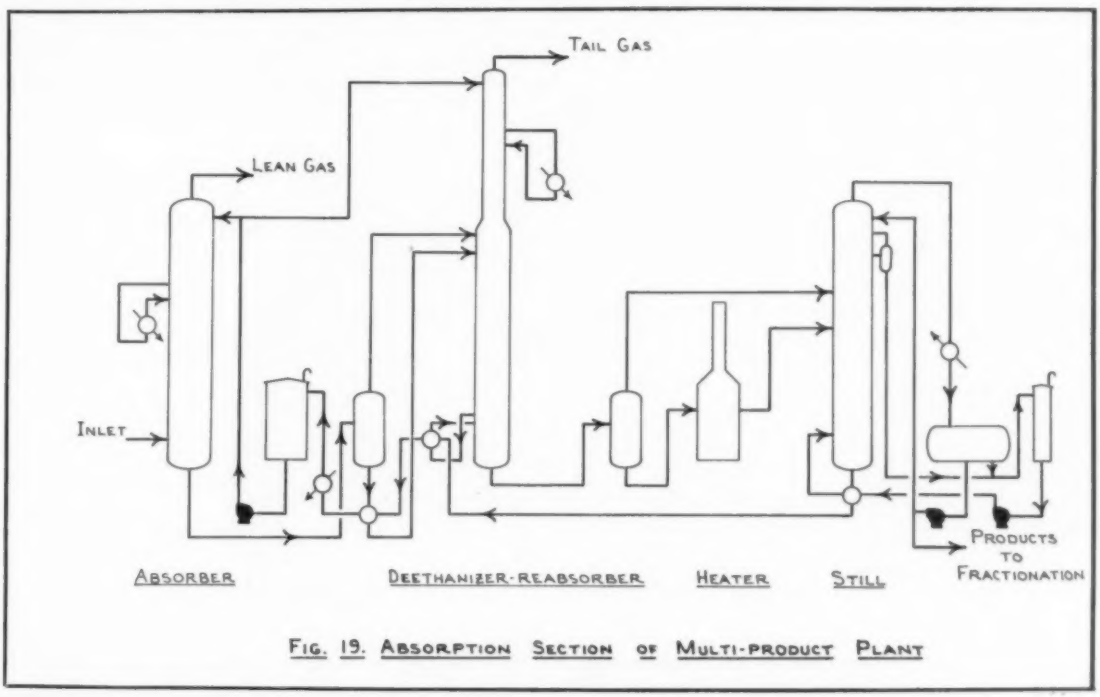

FIG. 19. ABSORPTION SECTION OF MULTI-PRODUCT PLANT

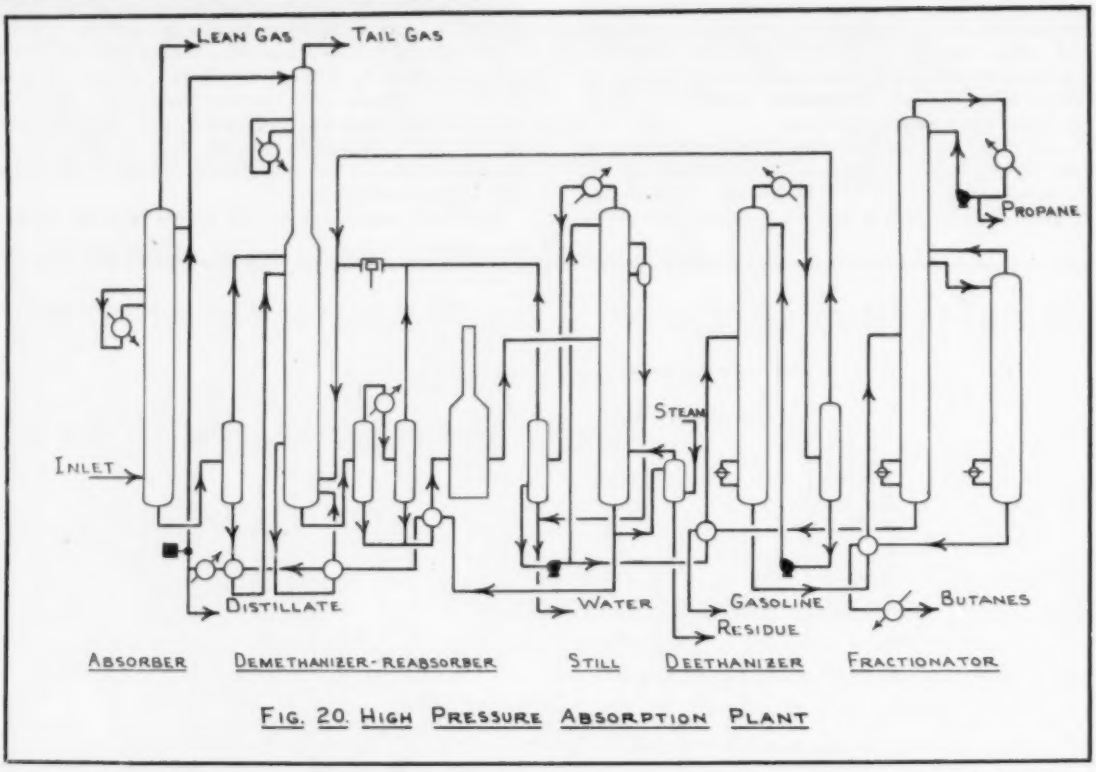

FIG. 20. HIGH PRESSURE ABSORPTION PLANT

demethanizer will be significant. It is usually less, however, than might be expected since loss of a small amount of heavy ends reduces the loss of intermediate components, and any loss is retained by the recycle. Overhead gas can be cooled and the condensed liquids returned to the system at a suitable point such as below the feed to the non-refluxed column. Cooling of this overhead gas may be particularly desirable to reduce compression temperatures and load.

Optimum Recycle

Determination of the optimum conditions for a complex recycle is difficult. Usually, the number of variables involved requires that a system and conditions be selected and the recycle calculated to enable analysis of heating, cooling and recompression loads. For example, it is desirable to carry out demethanization at a high pressure to reduce compression load for the tail gas and to reduce the lean oil requirement of the absorption section. At the same time, it is necessary to select a pressure sufficiently low to reduce the amount of recycle gas and related loads.

A plot of the equilibrium constant for ethane as a function of convergence pressure is illustrated in Fig. 22. This chart indicates that operating pressure must be kept well below the convergence pressure to realize the high value necessary for a low recycle.

Even at low pressures the equilibrium constant is affected by the convergence pressure which is in turn a function of the composition. More light material in a fixed system causes a higher convergence pressure, and therefore a higher equilibrium constant, the phase equilibrium of the lightest component being changed in much the same manner as when a foreign gas, such as stripping steam is introduced. That addition of heat at an elevated temperature is not very effective in improving the separation effect is also demonstrated by Fig. 22.

A cycle which includes only the operations of heating, cooling, recompression and simple separation may give the desired results, but a cycle which includes at least one stage of fractionation is usually more effective. Removal of undesirable light material early in a process is particularly important to improve the effectiveness of simple separation further in the process.

Simple separation should be carried out at the lowest practical temperature to take advantage of the larger spread between equilibrium constants causing more effective separation. It is important to find the optimum pressure for separation of gas from a distillate or oil due to the convergence of the equilibrium constants. This pressure can normally be lowered by a reduction in temperature.

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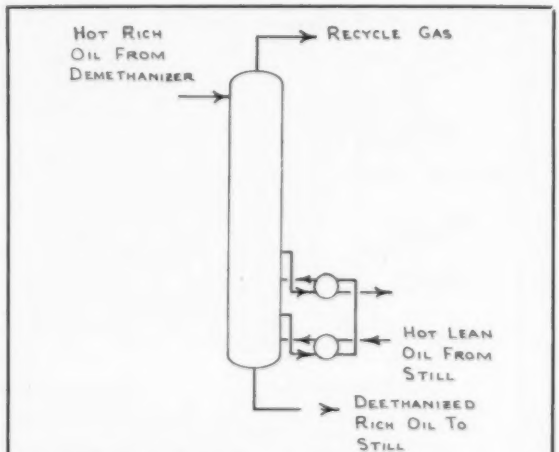

FIG. 21. RICH OIL DEETHANIZER

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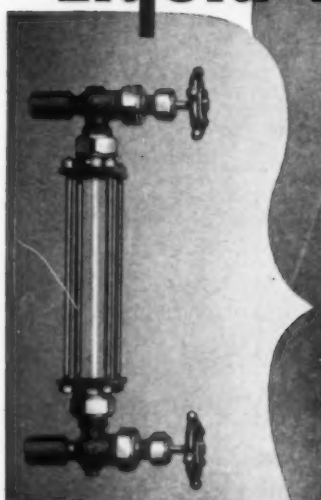

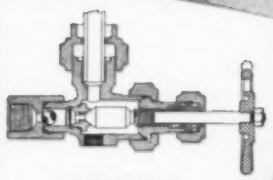

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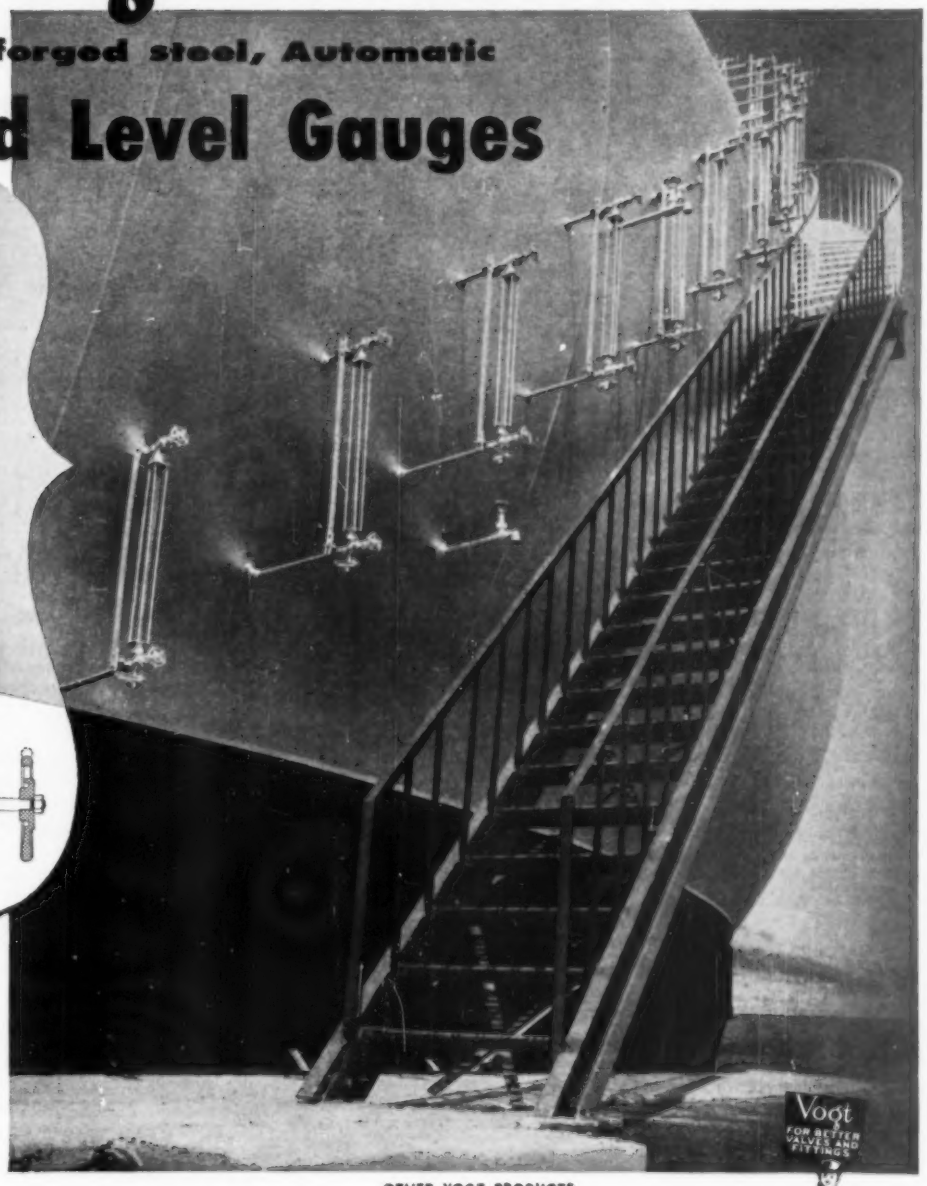

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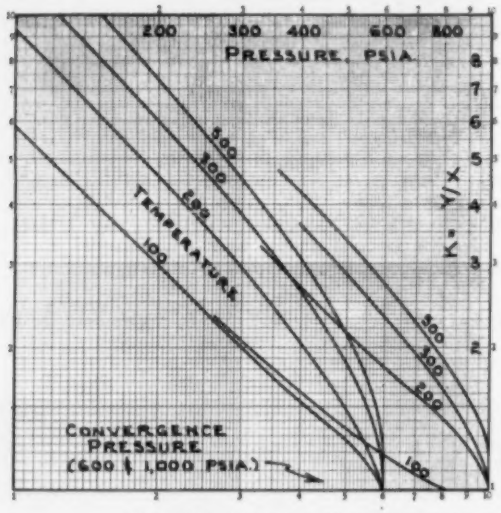


FIG. 22. ETHANE EQUILIBRIUM

out excessive loss to the lean gas is the most economical. When make-up oil is required or the initial charge obtained for a plant, first cost is not as important as the properties of the oil. At low pressures a high molecular weight oil is required but at usual pipeline pressures, 160 to 180 mol wt oil is often used.

Using Fig. 23, effect of reducing oil molecular weight on oil circulation can be determined for a given contact ratio, which in turn will effect a given absorption. If actual gal per mol for a particular oil is known, a new line can be added to the chart for comparison.

Oil Rectification

Effectiveness of lean oil in absorbing desirable fractions from the rich gas is significantly reduced if these fractions are not thoroughly stripped from the oil.

It is not unusual to find that recovery can be increased considerably in an older plant by a small improvement in the rectification system. A fraction of a percent of recoverable product in the tail gas from a plant represents considerable loss in production. A lean gas analysis may not reveal this loss unless care is taken in the laboratory to establish the heavy end content.

Rectification is generally accomplished by heating to around 500 F and stripping with steam. Steam requirement is about six pounds per mol of lean oil, increasing with increase in pressure and decrease in temperature. Heating to a temperature much above 500 F is generally not practical because cracking and troublesome coke formation begins to start at heater tube surface temperatures around 700 F. Cost of suitable material to meet these elevated temperatures is high and higher temperatures do not significantly improve separation.

Stripping is usually carried out at around 100 psi. In some cases, however, the overhead product will not be totally condensed at this pressure and a pressure up to 200 psi may be practical to gain appreciable condensation of the overhead product and to reduce recycle or recompression loads.

An interesting situation occurs when the rich gas contains as the heaviest fraction a material which cannot be sold with the gasoline due to end point requirement. Even if a side stream of lean oil is removed as a separate product, this fraction will build up in the lean oil, causing excessive loss to lean gas.

Loss of even part of this recoverable fraction is particularly significant because it is generally the most valuable fraction to be recovered. As a solution, a distillate product may be removed from the still above the feed point or it may be stripped from the hot lean oil.

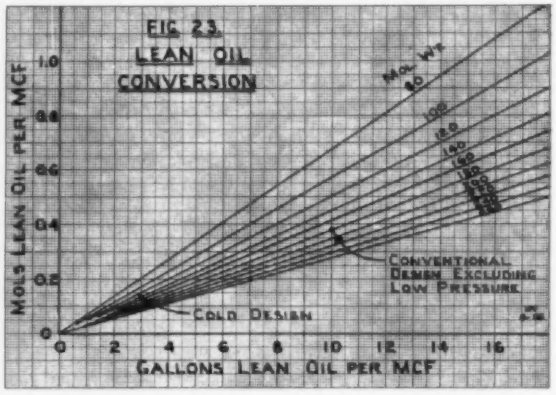
Conventional absorption may not be the most practical scheme of processing in such a situation. It is therefore quite important to determine the properties and quantity of heavy fractions in gas to be processed to enable an effective method of recovery to be incorporated in the initial plant.

Side Cooling

Side cooling of absorbers is often practical especially in situations where there is considerable difference between the temperature of cooling water and the normal absorption temperature. The larger the temperature rise, the more effective and important side cooling becomes. Oil from the tower is usually circulated once through a cooler by an elevation head provided between two trays to avoid pumping. Provision is made for normal overflow from the upper tray in the event of excessive pressure drop.

Product Fractionation

The fractionation system shown in Fig. 20, consisting of a primary column with a side column, has become popular. Less equipment is required and operating costs are generally lower than for individually refluxed columns. Also,



additional flexibility of individual towers is not usually required.

When individual towers are used for products, usually the lightest product is removed overhead from the first column, then the next lightest, and so on. This scheme has the lowest cost of operation. If a product is condensed twice, it takes additional heat and cooling water. The exception is the situation where there is a relatively large amount of the heavier products and removal of several lighter products initially will enable use of one or more towers of a smaller size, reducing initial cost.

Fractionation of products is generally carried out at the lowest pressure which will allow a 20 to 30 F difference between the condensed overhead product and cooling water. Since relative volatilities decrease with increase in temperature (and therefore with increase in pressure), greatest separation effect can be realized at lower pressures. However, it may be desirable to increase the operating pressure to increase the capacity. It may also be possible to increase the re-flux rates sufficiently at an elevated pressure when operating at load to improve separation.

Sometimes it is practical to recover heat from overhead gas. The higher overhead vapor temperatures required for adequate energy transfer rates would usually require higher operating pressures.

Editor's note: Part 4 of Modern Gasoline Plants — Abbreviated Plants — will be in the August 1958 issue of *The Refining Engineer.*

DETERMINATION OF KW RATING OF ELECTRIC HEATERS TO MAINTAIN STORAGE TANK TEMPERATURES

This nomograph is used for outdoor tanks with three inches of rockwood insulation or equivalent and an average wind velocity 15 mph. The heater rating obtained is sufficient to supply the convection and radiation losses from the surface of the insulation. Additional KW capacity must be installed to raise the temperature of the contents. Because of the many variables involved, the result obtained is not exact, but rather a close approximation.

Example

Determine the recommended KW rating of a heater to maintain an 8 ft diam by 26 ft 8 in. lg insulated storage tank at 325 F if the ambient temperature is 25 F.

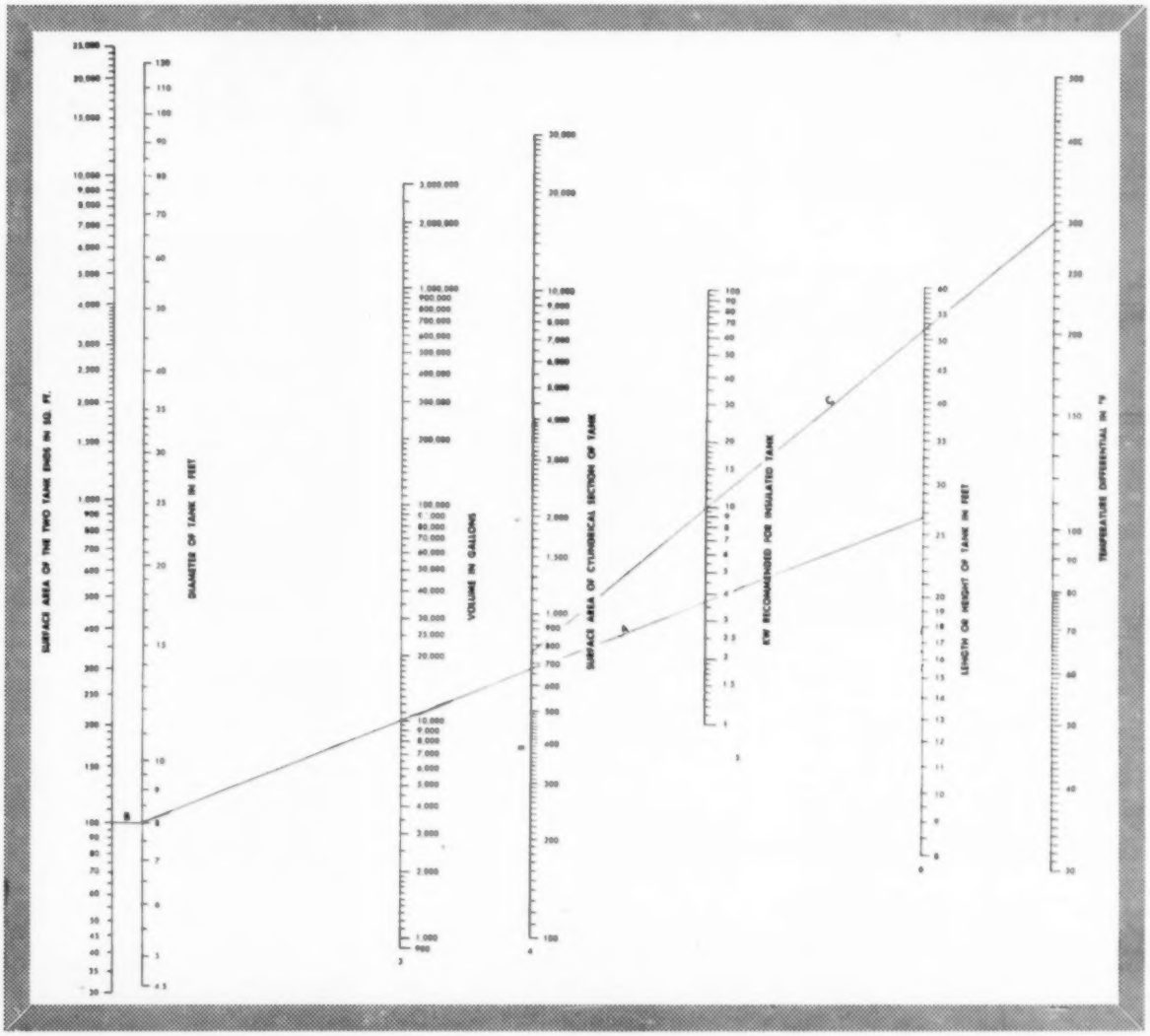
A. Connect 8 ft on scale (2) with 26 ft 8 in. on scale (6) by a straight line A. The intersection of this line with scale (4) gives the area of the cylindrical portion of the tank as 660 sq ft.

B. To determine the total area of both heads of the tank draw a horizontal line B through 8 ft on scale (2) and read area of both heads on scale (1) as 100 sq ft.

C. Adding the results of (A) and (B) will give the total surface area of the tank or 760 sq ft. Connect the point representing 760 sq ft on scale (4) and 300 F (325 F-25 F) on scale (7) by a straight (C) and read the KW recommended at the intersection of this line with scale (5) or *10 KW*.

Note: Scale (3) was added since the intersection of line (A) with this scale will give the volume of the tank in gallons.

Courtesy Hynes Electric Heating Division, Turbine Equipment Company


SURFACE AREA OF THE TWO TANK ENDS IN SQ. FT.
DIAMETER OF TANK IN FEET
VOLUME IN GALLONS
SURFACE AREA OF CYLINDRICAL SECTION OF TANK
KW RECOMMENDED FOR INSULATED TANK
LENGTH OR HEIGHT OF TANK IN FEET
TEMPERATURE DIFFERENTIAL IN °F
A
B
C

Refining & Petrochemical Personals

Donald M. Cox, assistant general manager of Esso Standard Oil Company's supply department, succeeds **George T. Piercy** as general manager. Piercy has been appointed assistant manager of the coordination and petroleum economics department of Standard Oil Company of New Jersey.

D. M. Cox

G. T. Piercy

Warren C. Wilson has been named assistant to the manager of Bayway refinery of Esso Standard Oil Company. Wilson, who started his Esso career at Bayway, had been serving as head of the Esso manufacturing department's safety division for the past two years.

William T. Tierney has been promoted to assistant superintendent of the Texaco Research Center at Beacon, New York. He was formerly an assistant supervisor of the products application department at the center, the company's largest research facility. **Dean C. McGahey**, formerly group leader in that department, was named to succeeed Tierney. **John R. McLean** has been promoted to group leader succeeding McGahey.

Daniel F. Cameron, Ponca City, Oklahoma, chief process engineer in Continental Oil Company's manufacturing department, has been selected from American industry to receive a 1958-59 Sloan Fellowship at the Massachusetts Institute of Technology, Cambridge, Massachusetts.

Harry Horsch has been appointed manager of supply and distribution for The Bay Petroleum Corporation. Horsch was formerly with the Phillips Petroleum Company for 19 years. **William R. Uhlhorn** was promoted to assistant general sales manager for refined petroleum products and **Elton M. Shearer** to assistant general sales manager for LPG sales. Both formerly served as administrative assistants to the vice president in charge of sales.

Bob L. Galloway, superintendent of Cities Service Oil Company's new projects development section, has been promoted to assistant to the division manager. **George C. Vaughan** succeeds Galloway after having been in the section since 1953. **L. T. Botts,** assistant to the general superintendent of the division in the field of operations and plant personnel, has advanced to superintendent of plant operations. **D. G. Thoes,** who supervised the operation of several Kansas plants, has been appointed assistant superintendent. **Frank M. Allen** had been supervising the operation of several Oklahoma plants. He will hold new position of assistant superintendent.

L. H. Davies has supervised the operation of several Texas plants and will also be an assistant superintendent. **D. W. Bellinger** became a member of the new projects section of the gasoline division in 1954, and will assume new duties as production engineer under Botts. **G. W. Duren,** senior process engineer at the Bartlesville plant, will direct the activities of the gasoline division's engineering and construction department. **M. F. Finfrock,** who was process engineer in the company's gasoline division and **D. F. Hogsett,** a member of the gasoline division's engineering section, will coordinate major construction projects as project engineers under Duren.

A pair of Esso Research and Engineering Company scientists — **Dr. Bruce G. Gillespie** and **Chester L. Read** — have been appointed research associates. **Dr. Roy A. Westlund Jr.,** has been appointed a section head in Esso Research and Engineering Company's chemicals research division after returning from a year's assignment at the Abingdon Labs of Esso Research Ltd. in England. **Dr. John F. Ryan** has been named a section head in the chemicals development division after having served as acting section head. **Erving Arundale** will move from his post of assistant director in the technical service unit to become assistant director in the firm's chemicals research division. **Robert F. Leary** will leave his post as assistant director in the chemicals research division for an assistant director's position in the technical service unit. **Dr. George P. Baumann** and **George Claypole** have been named engineering associates.

R. B. Williams has been promoted to research specialist in Humble Oil & Refining Company's research and development division.

John W. Miller has been employed as general manager of the Wrenshall refinery, International Refineries, Inc. He was formerly manager of export sales for Creole in New York City.

Alan Beerbower, a chemical engineer with the Baltimore refinery of Esso Standard Oil Company for the past 12 years, has rejoined the staff of Esso Research and Engineering Company. Formerly Beerbower spent nine years with Esso Research.

C. M. Mockler, fuel oil division manager, has been named manager of the liquefied petroleum gas division of the Shell Oil Company. Succeeding Mockler is **R. W. Carr,** who since last July has been on special assignment in the fuel oil liquefied petroleum gas department.

Dr. Lloyd A. Nicolai has joined Esso Research and Engineering Company as an assistant director in the firm's petroleum development division. He has been an assistant director at the affiliated Esso Research labs in Baton Rouge.

Raymond F. Winch, chief of the fuel development section of research and development of Sun Oil Company, has won a 1958 Sloan Fellowship for a year's executive development training at Massachusetts Institute of Technology.

Oscar Larson, manager of the Avon refinery since 1955, has been promoted to manufacturing manager of Tidewater Oil Company's 7 state and Hawaii western division. He succeeds **Thomas O. Edwards** who recently retired after 37 years with the company.

Robert O. Goodykoontz has been named general manager of Esso Standard Oil Company's marketing department. His former post as assistant general manager of that department will be filled by **George W. Butler,** who has been serving as assistant marketing coordinator, North America and Africa, for Esso Standard's parent company, Standard Oil Company of New Jersey.

Frederick R. Walser, previously employed by the Houdry Processing Company, has been designated as a senior engineer in the engineering department of Lion Oil Company Division of Monsanto Chemical Company. **Ernest M. Peres Jr.,** previously employed by the Ethyl Corporation, has become project investigator in New Orleans for the company.

J. E. Fenex, manager of Continental Oil Company's refineries in the Rocky Mountain region for the past 10 years and a veteran of 36 years with the company's manufacturing department, has retired. He has been a stillman, shift foreman, assistant superintendent and superintendent during his many years with the company.

J. E. Fenex

Orville W. Taylor has been assigned as senior engineer of the Henry, Illinois, general chemicals plant of B. F. Goodrich Chemical Company. He was formerly utilities engineer for Goodrich's chemical plant in Calvert City, Kentucky.

J. A. Vickers, president, The Vickers Petroleum Company, Inc., has been elected to the board of governors and the executive committee of the board, Midwest Research Institute, Kansas City, Missouri.

A. M. Braswell has been promoted to senior design engineer and **B. B. Ashby** and **J. C. Dickson** to senior chemical engineers in the technical division of Humble Oil and Refining Company's Baytown, Texas, refnery. **R. A. Speed** has been promoted to senior research chemical engineer in the research and development division at Baytown research center.

L. P. Blaser has been appointed general manager of manufacturing of the British American Oil Company, Ltd. He was formerly chief engineer and succeeds **J. W. Morgan,** who has been named vice president.

H. A. Shabaker, of the foreign operations engineering staff of Houdry Process Corporation, has been appointed technical assistant to **Theodore A. Burtis,** president. **Alexander K. Logwinuk,** senior process engineer, succeeds Shabaker.

Forrest H. Blanding has been named assistant manager of Esso Standard Oil Company's economic and marketing research division. Blanding is currently serving as head of the division's distribution and exploratory research section. This post will be filled by **Harold A. Ricards,** who is currently in the process division of Esso Research and Engineering Company.

Refining Books to Read

Petroleum Refinery Engineering, *by W. L. Nelson, published by McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, New York. Pages, 960. Price, $15.*

This fourth edition, in addition to being a text in petroleum refinery engineering and a handbook of refinery engineering technology, introduces more information on foreign crude oils and their evaluation. A new appendix analyzes and compares foreign crude oils with United States oils. More detailed information on physical properties of catalysts, as well as new material on solvent extraction, vaporization, thermal cracking and platinum catalyst reforming.

ASTM No. D92-57 and ASTM No. D 1019-57T, *published by American Standards Association, 70 E. 45th Street, New York 17, New York. Price per copy, 30 cents.*

These copies are revisions of standards covering petroleum products. ASTM D92-57 describes a method of test procedure for determining the flash and fire points of all petroleum products, except fuel oils, and those having an open-cup flash below 175 F (79 C). The other copy is intended for the determination of olefinic plus aromatic hydrocarbons in gasolines, naphthas, kerosines and other petroleum distillates that are substantially free from butanes and butenes, and that have a 90 percent point not over 600 F.

Plant Design and Economics for Chemical Engineers, *by Max S. Peters, published by McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, New York. Pages, 511. Price, $11.*

This is an extensive book dealing with applied economics, particularly in the process industries and in design work. The book also treats methods and important factors in the design of plants and equipment. Illustrative examples and sample problems, at the end of most chapters, are used extensively.

Emulsions: Theory and Practice, *by Paul Becher, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 382. Price, $12.50.*

All modern developments in the theory and practice of emulsions are clearly explained in this book. This volume contains discussions of the chemistry of emulsifying agents, emulsifier efficiency as a function of composition and the technique of emulsification.

Polyurethanes, *by Bernard A. Dombrow, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 185. Price, $4.50.*

This book is well-written for the person who does not have a strictly technical background in the field of chemistry. It is also written for persons wanting to review the subject of polymers. The uses and possibilities of the polyurethanes are covered thoroughly.

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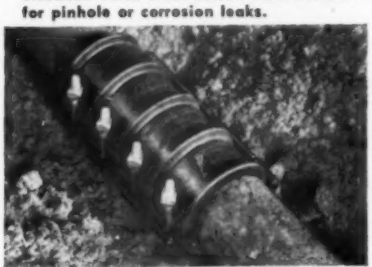

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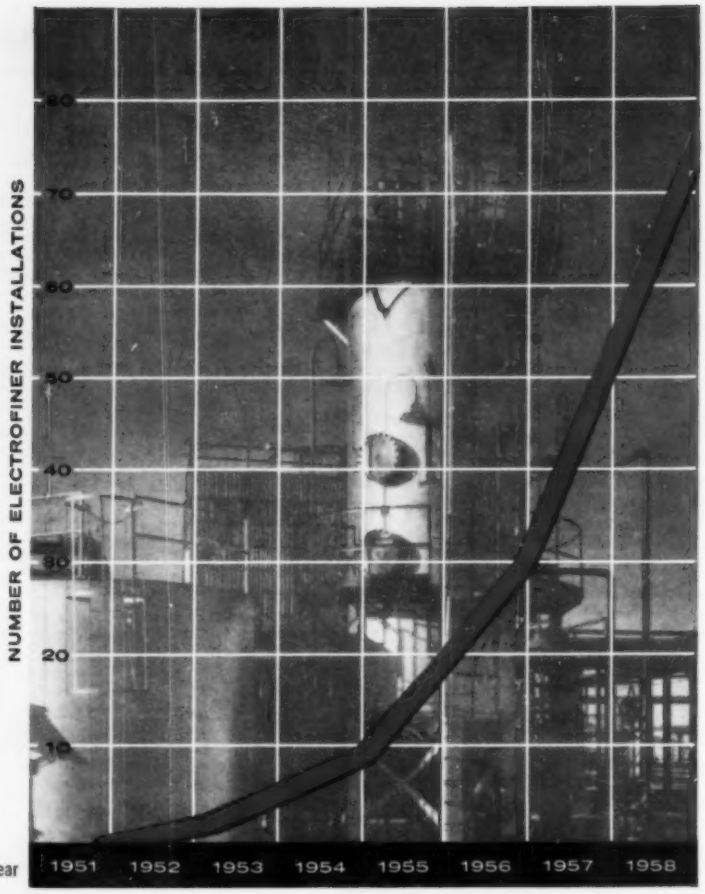

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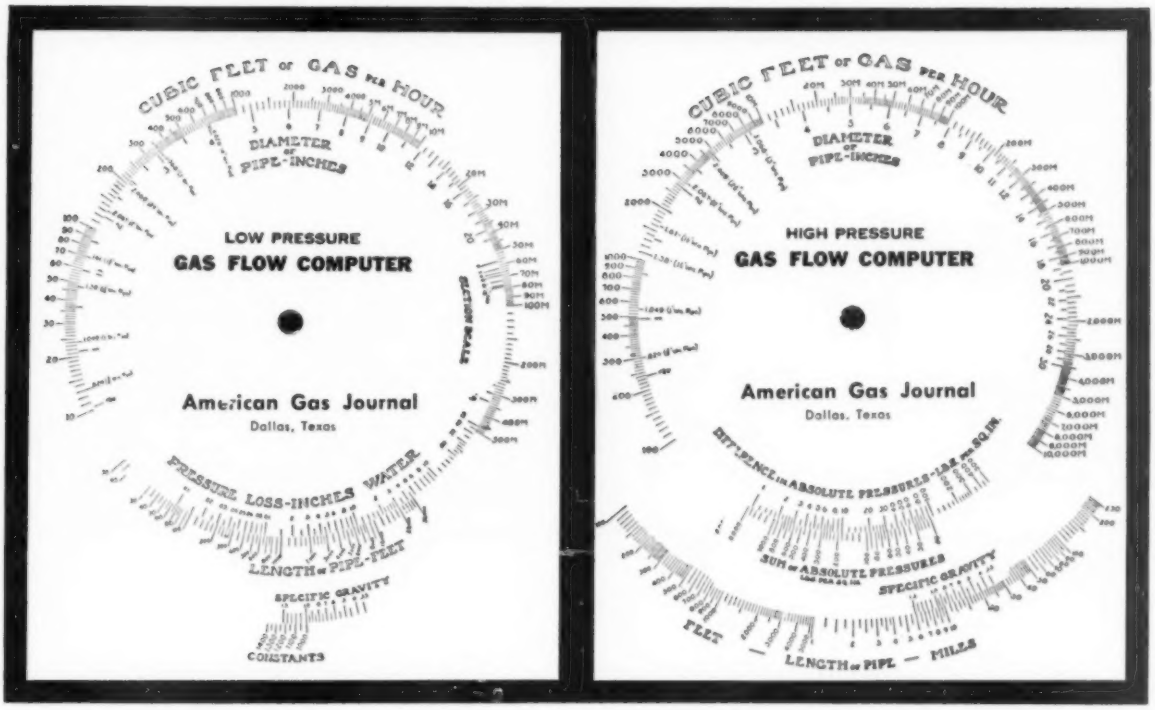

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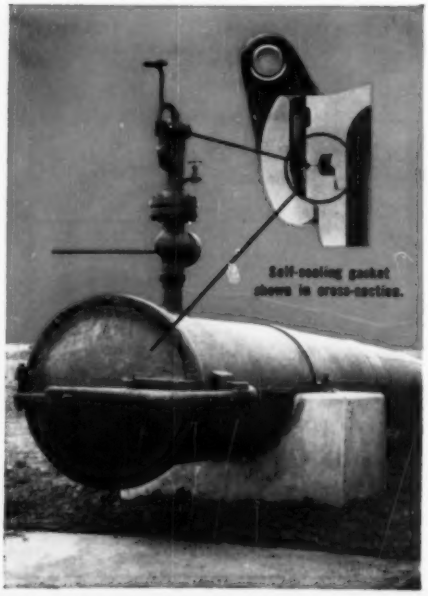

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GRAPHIC ENGINEERING DIGEST

Noise abatement in pipeline operations

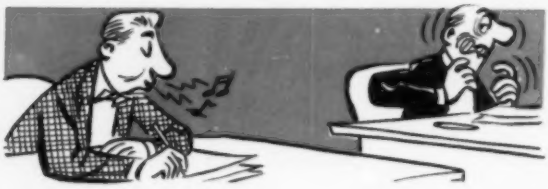
By **Seymour Lascoe,** *Natural Gas Pipeline Company of America*

Noise and its control is a subject upon which accurate knowledge is not too widespread. Noise has been blamed as a cause of insanity, nervous tension, nausea, inefficiency, fatigue, confusion, irritability, improper rest, hearing damage, and lowering the milk production of cows. Actually, some of these things are more imagined that real, and this is fortunate, because in this age machines are taking over more and more tasks. Almost everytime a machine process replaces a manual task, more noise results.
But first just —

What is noise?

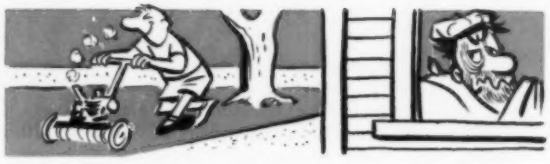
THIS IS NOT . . .

. . . BUT THIS IS



SOOTHING TO WHISTLER . . . . . BUT NOT TO LISTENER

Noise is usually defined as objectionable or unwanted sound. But this definition leaves loopholes, as shown in the illustrations. It is relatively simple to measure the intensity and frequency of a sound, but how do you measure annoyance or fatigue? Noise can have detrimental effects on human beings, and much work has been done along these lines by ASA Committee Z24-X-2. Much work remains to be done.



TOLERABLE NOISE . . . . . INTOLERABLE NOISE

Problem

AS INDUSTRY INCREASES IN EFFICIENCY MORE NOISE SEEMS TO RESULT. When we replaced 4-cycle horizontal engines in compressor stations with angle-type we got more noise. Larger engines are in increasing demand — some are more noisy than those of less horsepower. For pipelines, this is an urgent problem, because in the absence of complete data, legislative bodies are taking it upon themselves to establish regulations based on their interpretation of the available data. Communities are establishing anti-noise ordinances; states are granting compensation to workmen for hearing loss, and labor unions and insurance companies have become deeply involved in the noise problem.

Engineering aspects of noise abatement

NOISE PRODUCTION AND TRANSMISSION. Almost all sound is the result of something vibrating. It may be a string, a column of air, a reed, a pipe, a plate, or vocal chords. This vibration is caused by energy being put into a system that is capable of vibrating in response to the input energy. The vibration becomes coupled to the surrounding air causing pressure variations known as a sound wave. When the sound wave is detected by the ear it becomes "heard." So we have a pretty definite chain of events to deal with. Our problem is to break that chain, or, what is usually more practical, to put one or two weak links in it.

Acoustical treatment

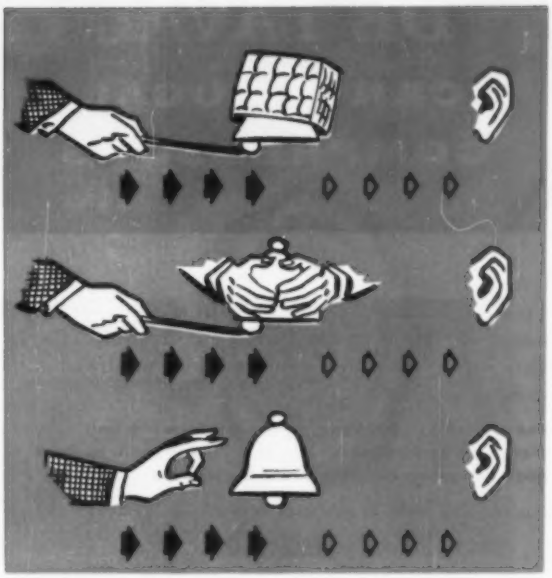
Build a box around the noise source, line it with sound absorbing material, and construct the exterior so it will not vibrate at the frequencies involved. Another way: The vibrating member is covered with sound insulation — but unfortunately sometimes, this insulating material is also a good heat insulator that may require special ventilation if the object enclosed generates heat.

Vibration suppression

This method involves the use of vibration mountings, decoupling devices, and means of increasing the mass and stiffness of the system in order to alter the frequencies at which it will respond. The idea is to dissipate energy causing the vibration so that successive impulses cannot reinforce each other, thus preventing the build-up of large amplitude vibrations. Decoupling devices prevent vibration from being transmitted from one part of the system to another.

Reducing energy input

A third method is to reduce or re-direct the energy that is causing the vibration. This method frequently involves redesign of equipment, which is more properly the problem of manufacturers. In some instances, however, the user of a machine can design a device or employ a method that will reduce the energy causing vibration. This method does not lend itself well to generalization since the form that it takes depends on the specific application.



Noise problems resulting from gas pipeline operations

In general there are four types of installations operated by gas pipelines that are capable of causing noise problems. These are: *Regulator stations; meter stations; compressor stations, and blow-offs.* The problems they can cause are annoyance to neighbors and exposure of operating personnel to the possibility of hearing damage as well as other physical and mental disturbances.

In 1957 the Pipeline Research Committee of the American Gas Association began to support research on "Noise Abatement At Gas Pipeline Installations." The program has been in progress a little over a year now, and the work on regulator and meter stations is almost complete. The work on compressor stations will be started this year.

Noise abatement at regulator and meter stations

Data came from 13 field locations. Here are the results of this study:

1. Cause of the noise is not the regulator itself but turbulence it causes in the gas stream, which sets the piping system into vibration.
2. Piping both upstream and downstream from the regulators is set into vibration, but the principal noise sources are the headers at right angles to the gas flow and the piping immediately downstream from the regulator.
3. Noise levels up to 118 db are encountered even under reduced load.
4. Frequency varies between 600 and 10,000 cycles with peaks between 2000 and 4000.
5. Flanges, valves, and other massive components radiate little noise but do tend to act as nodes in the vibration pattern. They transmit vibration along the piping.
6. Meter runs did not contribute greatly to the sound field.

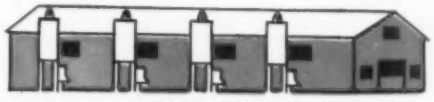
As a result of this study, the first method of attack is aimed at reducing the energy that is exciting the piping into vibration. This energy source is turbulence in the gas stream. To reduce this turbulence a gas stream filter that resembles a small pulsation dampner has been designed for installation immediately downstream from the regulators. This low pass filter will pass frequencies below 500 cycles and attenuate those above. The filter has not yet been tested.

The second method of attack will be acoustical treatment of exposed piping. Severe noise offenders such as the downstream headers will be encased in a double-walled box, which has two courses of sound absorbing material. Other portions of the piping system will get a single-walled box or a simple snap-on glass fiber pipe covering encased in protective covering. Results of this work should be available from AGA sometime this year.

Compressor stations

Noise problems at compressor stations are due principally to the operation of the main engines. The high speed, high horsepower, angle type engines have resulted in noise levels well over 100 db in main engine rooms. Daily exposure to such noise levels over a period of years may be harmful. In addition, noise emerging from air filters and mufflers located outside the engine room is frequently annoying to neighbors.

The main engine room noise problem is undoubtedly the most difficult encountered in the gas transmission business. The variety of main engines and associated equipment in use, differences in construction and piping arrangements, and the



multiplicity of noise sources all combine to make this a most complex problem.

Some of the means of lowering the noise level in engine rooms may be so objectionable to the operators that they would prefer to have the noise. So we must try to confine our efforts to corrective measures that do not create unusual or difficult operating and maintenance problems.

DE LAVAL CENTRIFUGAL COMPRESSORS used for light gas, in Magnolia

As part of the expansion program in the Beaumont, Texas refinery of the Magnolia Petroleum Company, De Laval turbine-driven centrifugal compressors are on stream in three important applications:

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- **pumping hydrocarbon gas in a compressor station**
- **supplying combustion air on a giant cat cracker**

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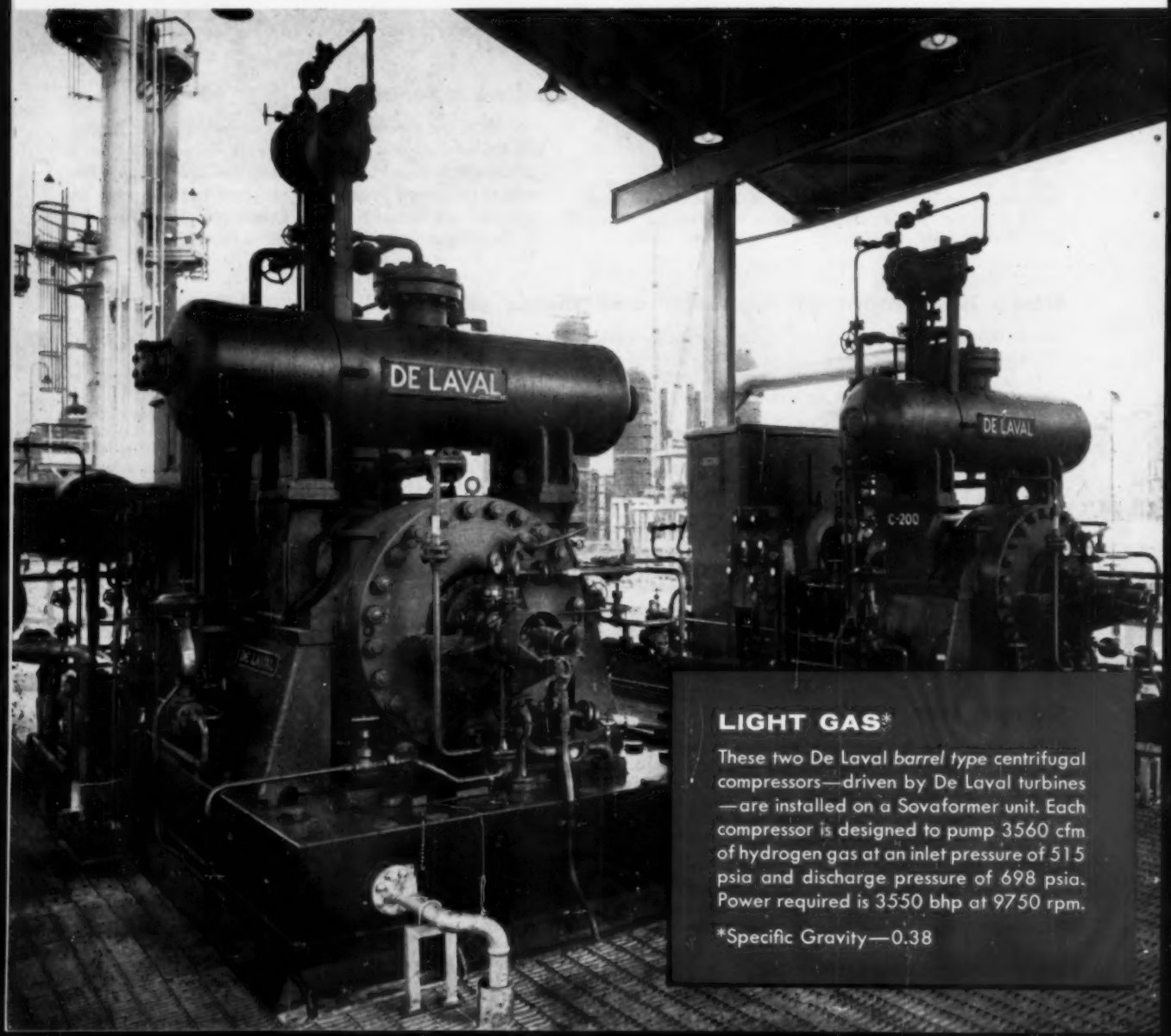
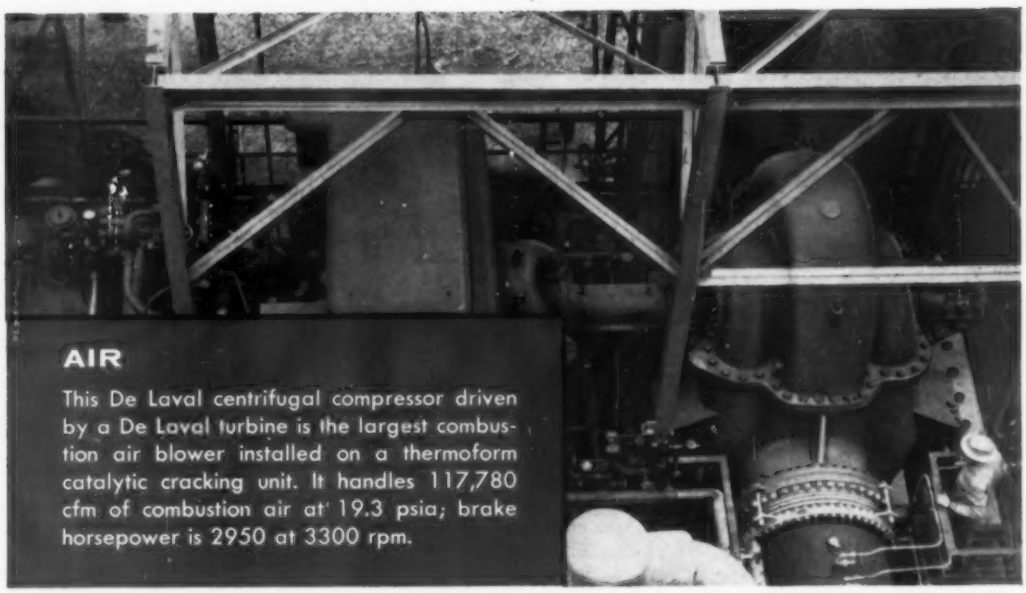


LIGHT GAS*

These two De Laval *barrel type* centrifugal compressors—driven by De Laval turbines—are installed on a Sovaformer unit. Each compressor is designed to pump 3560 cfm of hydrogen gas at an inlet pressure of 515 psia and discharge pressure of 698 psia. Power required is 3550 bhp at 9750 rpm.

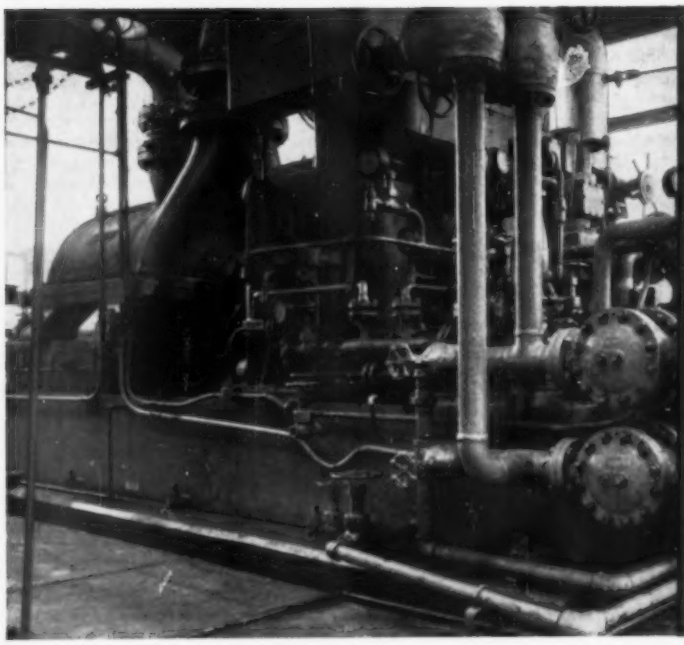
*Specific Gravity—0.38

heavy gas and air handling Petroleum's expansion program



AIR

This De Laval centrifugal compressor driven by a De Laval turbine is the largest combustion air blower installed on a thermoform catalytic cracking unit. It handles 117,780 cfm of combustion air at 19.3 psia; brake horsepower is 2950 at 3300 rpm.



HEAVY GAS*

This De Laval centrifugal compressor and turbine installation is located in Magnolia Petroleum's number 1 gas compressor station. The unit is designed to pump 10,560 cfm of hydrocarbon gas at 65.0 psia with a suction pressure of 14.0 psia.

* Specific Gravity—1.376

DE LAVAL *Centrifugal Compressors*

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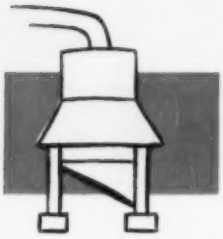
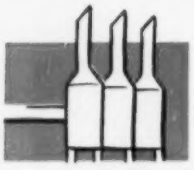


Air intake system

Air intakes often produce powerful, low frequency pulsations, which can rattle windows out over the countryside. The source is interruption of air flow by the engine valves, producing pressure variations at sonic frequencies, which travel through the intake system, entering the atmosphere at the open end. The solution may be to reduce these pressure variations before they enter the atmosphere by deliberately setting up a resonant condition by causing the air to flow through a restriction, then an expanded portion of the piping.

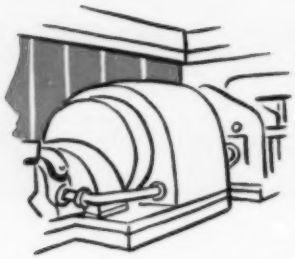
Another method is to insert a truncated steel cone about one-half the principal frequency wave length, just behind the air filter. A third method is to enclose the air filters in a heavy-walled enclosure.



Exhaust system

The portion of the exhaust header inside the engine room can radiate considerable noise. A sound absorbing enclosure around this header helps. In addition, the muffler shell itself may radiate some noise, which can be reduced by an enclosure. For any given application there are usually several different mufflers available. It may be cheaper in the long run to purchase equipment that will give maximum muffling.

Another suggestion for controlling muffler noise is to locate the mufflers on the roof of the building, with the roof constructed to direct the noise upward where it cannot be heard.



Building acoustical treatment

A common approach to the engine room noise problem has been to line the walls and roof with a sound absorbing material. This greatly reduces reverberation, thus giving the noise a directional quality. This enables operators to detect more easily the source of any unusual noise that may indicate the development of engine trouble. In addition, any other anti-noise measures can be better evaluated when the reverberation is decreased.

Most of the foregoing is a summary of measures companies have used in an attempt to solve noise problems. The AGA sponsored research program now in progress will likely produce additional and more effective noise abatement devices and methods for compressor stations.

Blow-offs

Most blow-off operations are infrequent and of short duration, and the only problem is protection of personnel in the immediate vicinity. Ear plugs are satisfactory. Occasionally long lengths of mainline may be blown down, a process that could take hours. In such instances, some sort of silencer would be very desirable. In other cases blow-offs may be in the vicinity of populated areas, causing an annoyance problem. Silencing in these cases would also be helpful.

The only blow-off silencer that has come to my attention consisted of a relatively high and large diameter stack lined with a sound absorbing material.

Specifications. There is one source toward which I hope we can look for help with our noise problems. That source is the manufacturers of the equipment that we use. We can perhaps encourage them to design equipment that will give us lesser noise problems by including in our specifications a paragraph that at least indicates that noise has become a factor in equipment selection.

It is, of course, impractical to specify noise levels that no manufacturer can meet. We can, however, ask for a statement of the noise levels to be expected from operation of the equipment, and then make comparisons between bidders. In cases where we are adding to an existing installation, we can specify a noise level that will not make the existing situation worse.

Conclusions. In any noise abatement program there comes a time when it must be asked, "Has enough improvement been achieved?" There is at present no simple, direct answer to that question, especially when the problem involves prevention of possible hearing damage. There is no widely accepted standard to measure against.

Just to give an idea of the diversity of opinion that exists between authorities on the sound level they consider safe for continuous exposure, more than 200 replies to a questionnaire showed opinions ranging from 60 db to 105 db.

So far as noise in gas pipeline operations is concerned, if our problem is annoyance to neighbors, we must reduce the noise to a point where it is no longer annoying.

If our problem is prevention of hearing damage among people who are exposed to high noise levels daily for several hours, the best information available indicates that we should try to reduce the noise level below 100 db. This probably will protect most people. There are a few people who are very susceptible to hearing damage. To protect them would require noise levels under 90 db.

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ACKNOWLEDGMENT. This is a digest of a paper presented at the American Gas Association Distribution, Production and Transmission Conference, May 5 to 9, 1958, in New York City.

What to do about the noise problem at pressure reducing stations

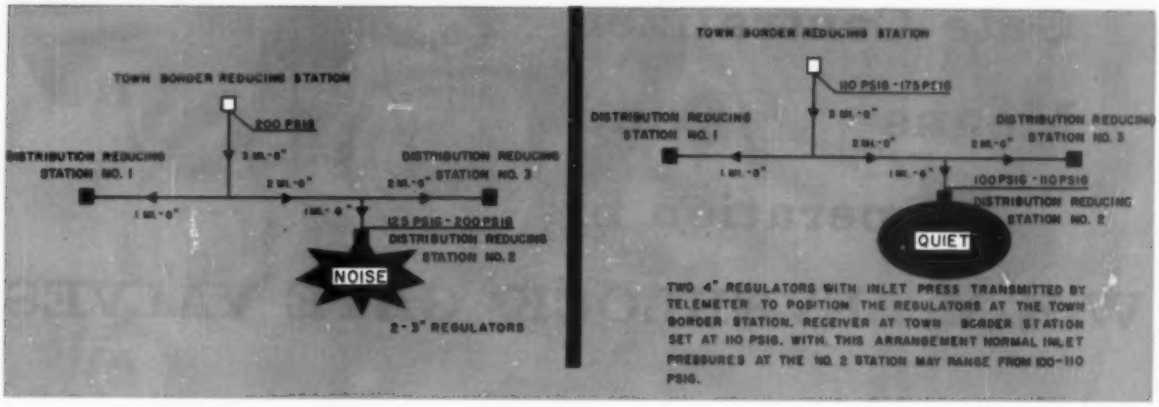
Robert M. Watson, *Transcontinental Gas Pipe Line Corporation*

The noise problem at pipeline pressure reducing stations falls into two categories: (1) Noise problems after the fact, and (2) noise problems before the fact.

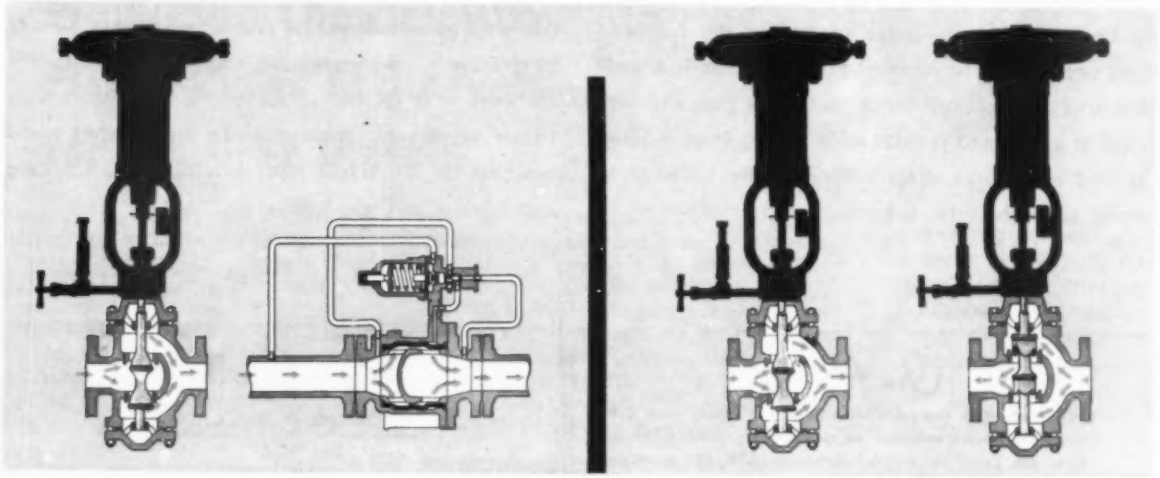
Noise problems after the fact are those arising **after** *a pressure reducing station is constructed and put in service. In most instances the station was constructed in an isolated location and the noise problem was not a consideration in its design. But several years later when the station is operating near capacity, Joe Doaks, we'll say, builds a $25,000 home with all bedroom windows within 100 ft of the station. He doesn't like it, and this is a noise problem* **after** *the fact.*

Noise problems **before** *the fact come when the station site is located on a small lot surrounded on three sides by residents who turn anything but a deaf ear to the noise of the new station. In either case the noise problem must be solved.*

Nine ways to reduce this noise


TOWN BORDER REDUCING STATION
200 PSIG
DISTRIBUTION REDUCING STATION NO. 1
DISTRIBUTION REDUCING STATION NO. 3
125 PSIG - 200 PSIG
DISTRIBUTION REDUCING STATION NO. 2
NOISE
2 - 3" REGULATORS
TOWN BORDER REDUCING STATION
110 PSIG - 175 PSIG
DISTRIBUTION REDUCING STATION NO. 1
DISTRIBUTION REDUCING STATION NO. 3
100 PSIG - 110 PSIG
DISTRIBUTION REDUCING STATION NO. 2
QUIET
TWO 4" REGULATORS WITH INLET PRESS TRANSMITTED BY TELEMETER TO POSITION THE REGULATORS AT THE TOWN BORDER STATION. RECEIVER AT TOWN BORDER STATION SET AT 110 PSIG. WITH THIS ARRANGEMENT NORMAL INLET PRESSURES AT THE NO. 2 STATION MAY RANGE FROM 100-110 PSIG.

1. In some instances a reduction in noise level has been accomplished by reducing the pressure drop across the regulator. The use of telemetering in conjunction with large regulators has proved effective in a number of instances.



2. Changing from conventional diaphragm-operated regulators to rubber-sleeve through-flow pattern regulators has proved effective in a number of cases. However, this may mean junking valuable equipment.

3. Changing the inner valve-plug to "Vee" port sometimes does the trick.

4. In some instances changing the direction of the flow has helped.

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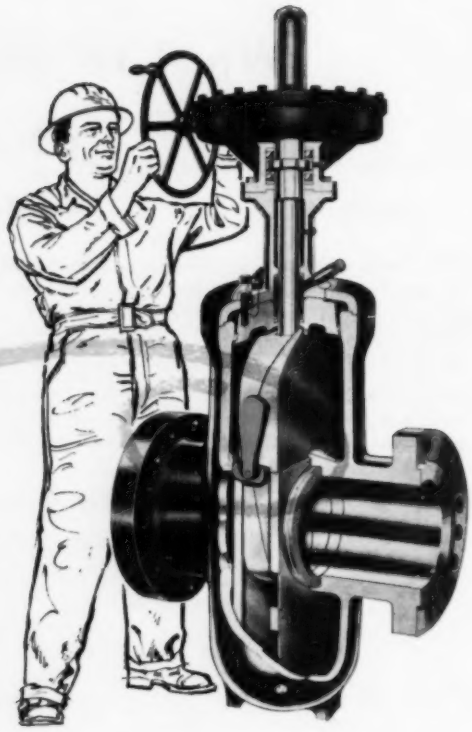

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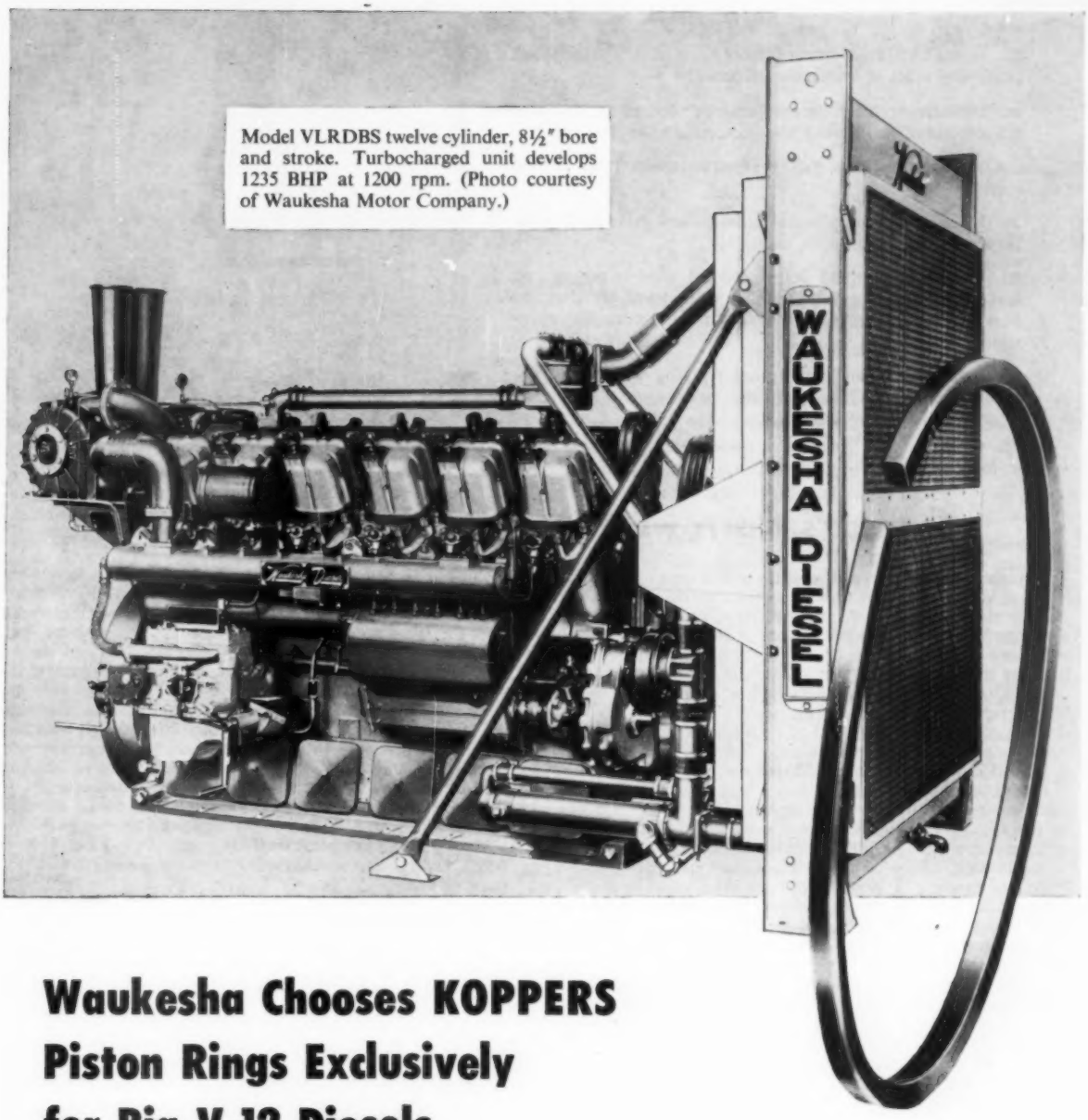

Model VLRDBS twelve cylinder, 8½" bore and stroke. Turbocharged unit develops 1235 BHP at 1200 rpm. (Photo courtesy of Waukesha Motor Company.)

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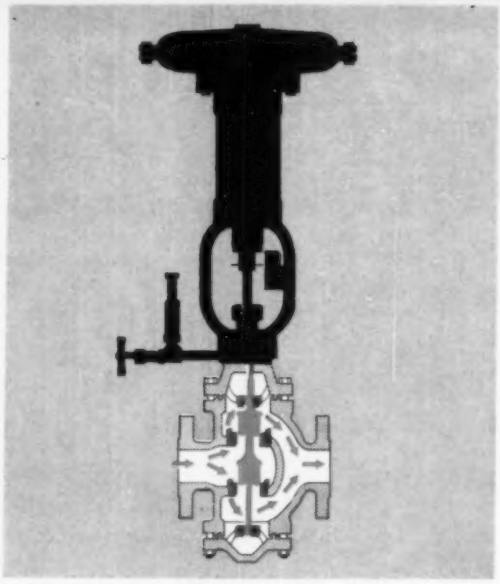


5. Going to a larger size regulator valve body with reduced plugs and seats is sometimes effective.

6. Installation of a noise dampener or silencer. At least one manufacturer is offering this equipment on the market.

Confining the noise has been accomplished by several methods:

7. Keeping all piping below ground level and installing the regulating equipment in a vault.

8. Keeping all piping below ground level, entering and leaving the reducing valves within an enclosed building, the building being designed to contain the noise as much as possible.

9. Insulating of all above ground piping with sound absorbing material. Glass wool and asbestos have been used effectively as piping insulation.

Case History:

Transco's Narrows Meter and Regulator Station

Transco's most successful solution to this type noise problem was accomplished at the station located on Clifton Avenue in the Borough of Richmond, New York. The station was constructed in a residential area as shown below. All of the above ground piping is housed in the 85 by 56 ft masonry building that has acoustical plaster walls and ceiling. Inside the building are one 6-in. and five 12-in. orifice meter runs. Six-in. through pattern reducing valves (No. 2) were installed on the downstream end of each run. Normal pressure drops across this station vary from 130 to 150 psig, and normal deliveries are 8 to 10 MMcf per hr.

One room houses the meter tubes, measuring and control equipment; the other room houses the regulators. Thanks to the contours of the lot, it was possible to construct the regulator room in the hillside.

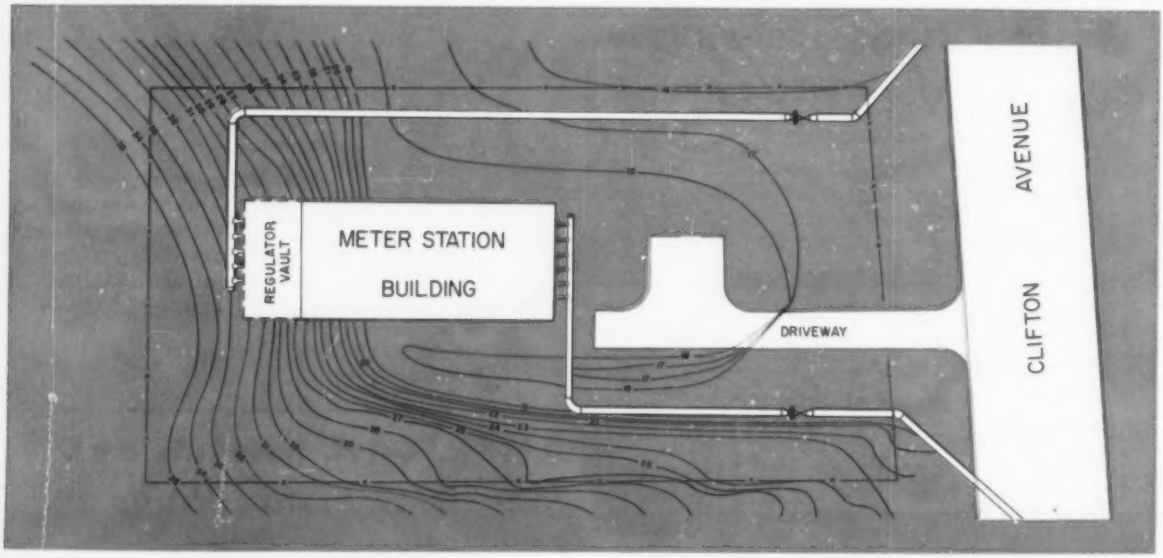
Since construction of this station some six years ago we have had one minor noise complaint. The noise in this instance came from two 8-in. blow-off risers on each side of a 20-in. block valve some 160 ft downstream from the station. The block valve was below ground, but the blow-off valves extended approximately 5 ft above ground level. This problem was corrected by insulating the 8-in. risers with 4 in. of glass wool held in place by sheet aluminum covering.

All our thoughts, plans, ideas, and discussions have been toward attacking the noise problem at pressure-reducing stations for the benefit of the customer. The old meterman likes the noise because it means things are going pretty well, but constant work around noisy regulators can impair an individual's hearing. All people working in or around pressure-reducing stations for prolonged periods of time should be provided with ear protectors and encouraged to use them. At least two manufacturers are offering sound protectors for the ear that have proved satisfactory for this service.

Noise created by pressure reduction is a problem that will be with us for many years. It is a costly problem and one that becomes greater as our markets expand and our line pressures increase. I do not believe we can eliminate the noise problem at pressure-reducing stations, but I do believe some research in this field will give us answers that will ease our problems.

Acknowledgment

This paper was presented at a panel discussion at the gas measurement session of the American Gas Association Distribution, Production and Transmission Conference, May 8, 1958, in New York City.



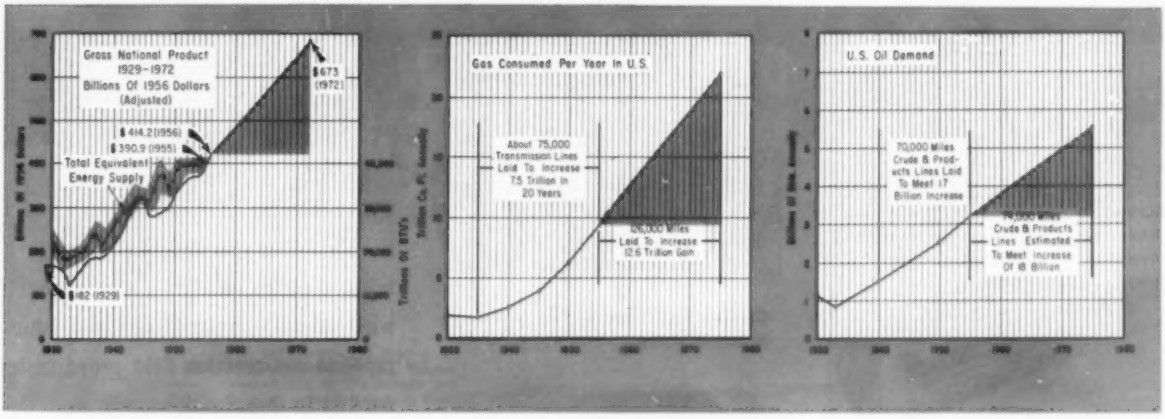
Pipeline Construction:

Yesterday, today and tomorrow

J. W. Hall
President, Hallmac Construction Company, Houston, Texas

During the past 30 years a myriad of improvements have come to pipeline construction — from the field, from engineering departments, and from manufacturers of equipment. Virtually all of these improvements had their origin in the competition that is an outgrowth of our system of free enterprise. Contractors have found better ways of laying lines in order to increase profits at lower prices for the client. Manufacturers have consistently improved laying equipment every year in order to increase sales and profits. And the pipeline companies themselves have continually worked to improve construction methods and techniques in order to obtain pipelines of the highest quality, constructed at prices that make the pipeline competitive with other means of transportation.

Why pipelines will continue to grow



$45 billion by 1970

This amount will probably be spent on new pipeline facilities in this country alone. The American Gas Association has estimated that the U. S. gas companies will spend about $36 billion by 1970 for new transmission and distribution lines and other facilities, so this estimate may possibly prove conservative. Products lines undoubtedly will sustain a steady growth, and some engineers are predicting that individual service stations one day will be connected to product distribution lines just as air bases are connected today. Crude oil lines, of course, will follow supply sources, and future imports will greatly affect them.

Energy, GNP and pipelines

As seen above, the U. S. energy supply curve has paralleled the Gross National Product (or total income) curve. This is the origin of pipeline growth. Simply stated — there has been a great increase in demand for energy, and the pipeline affords the most economical means of moving certain forms of energy to market. So long as pipelines continue to provide the most efficient means of moving their contents to market and so long as the market continues to expand, pipeline construction will continue at a proportionate clip. But when other means of transportation of energy become more efficient, pipeline construction will wane.

Bargain pipelines

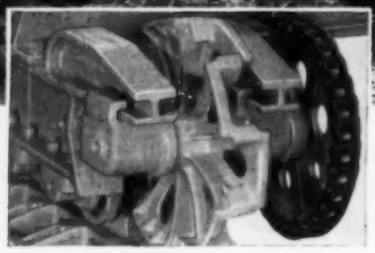
Today, there are few bargains that will rival pipeline construction costs. Going prices are but little more than they were 20 years ago for lines of equal diameter, despite the fact that the dollar has inflated and the cost of labor and equipment has advanced. The explanation lies in the increased efficiency of the pipeline spread. In the past 30 years, this mobile construction unit has progressed from a disorganized mule team operation to a mechanized one — so well organized that there is probably no mobile unit on earth — including crack military divisions — that can excel it. Moreover, almost every pipeliner has a built-in inventive streak that enables him to cope with difficult and unexpected problems that arise every day.

Equipment improves, too

As a matter of fact, some manufacturers estimate that each piece of mobile equipment improves in efficiency by about 2 percent per year — that is to say, each new model is

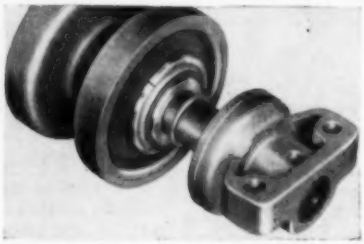
built for pipeline work

Carbody . . . wide and heavy to withstand stress. Three-piece removable bottom cover plate. Hinged center panel.



Crawler End Tumblers equipped with bronze seal rings.

Swing and Travel Shafts . . . large diameter with involute splining for greater reserve strength.



Crawler Rollers protected by bronze seal rings and by neoprene rubber O-rings.

The challenge of pipeline work has been a good test for the ruggedness and dependability of Insley excavators and cranes. Insley's wide-spread popularity and leadership in the pipeline construction field prove Insley's capability in meeting this challenge.

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Fig. 3671 — 2½" to 3½" x 6 Triplex Plunger Pump. Capacities of 191 to 375 barrels per hour at working pressures from 1575 to 800 PSI.

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for every oil industry need

2 percent better than the last because of increased horsepower, improved controls, etc. Another factor that has affected construction is the high skill of today's engineers and designers. Early lines were designed by the hip pocket method. Where companies lacked criteria and precedent, they simply developed individual formulas and principles. Many were concluded from erroneous logic. However, trial and error, research and development and good engineering have brought the pipelines a long way in recent years. But many exciting developments still lie ahead.

Pipeline construction progress

Right-of-way and route location

Yesterday. Thirty years ago, pipe-route surveys were sketchy — the only certainties were the beginning and end of the line. Damage claims were small at first, but this changed in recent years.

Today. Fantastically accurate aerial cameras and stereoscopic viewers plus aerial inspection take the guesswork out of route selection. Conformance to codes based on population count are difficult today.

Tomorrow. Radar equipment with unprecedented accuracy will improve route surveys. R-O-W's will be so well tended, pipelines will one day be sought by land owners. Pipelines will be straighter, too.

Hauling and stringing

Yesterday. Stringing was primitive, and little thought was given to protecting the pipe from gouges, etc., and out-of-roundness was tolerated.

Today. Pipe is guarded from the mill to the ditch. Gouges, etc., regarded as possible sources of failures. Specifications limit out-of-roundness.

Tomorrow. There will probably be fewer gouges, less out-of-roundness. One day pipe will simply be hauled to "pipeline machine." No stringing.

Clearing and grading

Yesterday. Minor ups and downs of terrain were reflected in finished line. Pipeliners invented the bulldozer to expedite backfilling, etc.

Today. Thanks to heavy equipment, the elevation profile of finished right-of-way is fairly level, and no longer resembles accordion.

Tomorrow. Lines may be laid to established grades, thanks to heavy equipment. Vegetation will be masticated and worked back into soil.

Ditching

Yesterday. Early ditching was done by hand, and its purpose was to protect the pipe from vandalism. Increased farming and larger diameter pipe required definite cover for the pipeline.

Today. Mammoth high-hp ditching machines make ordinary ditching a high-speed operation. Rock is the big difficulty in ditching. Improved drilling equipment, explosives, and time delay fuses minimize the problem.

Tomorrow. If predictions are fulfilled, sonic ditching machines will one day be on the line. Improved rock drills are coming, and a portable rock crusher will one day simplify the task of backfilling.

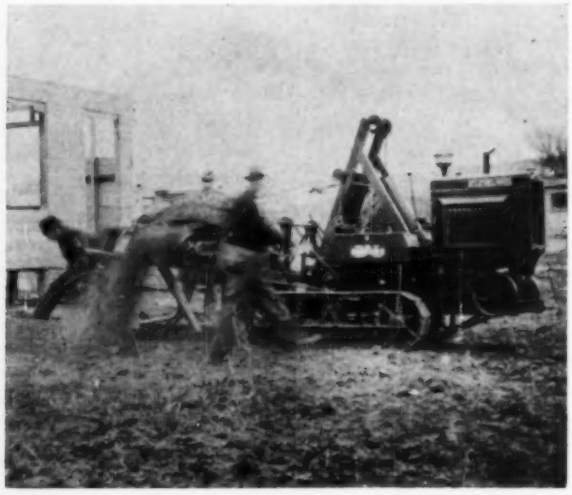
Pipe bending

Yesterday. Small diameter pipe was cold sprung by the pipeliners who jumped on the pipe between two supports. Later wrinkle bends were applied to the pipe as shown below.

Today. The bending machine is one of the most efficient machines on the right-of-way today. It can smooth-bend pipe up to 36-in. with no heat being necessary.

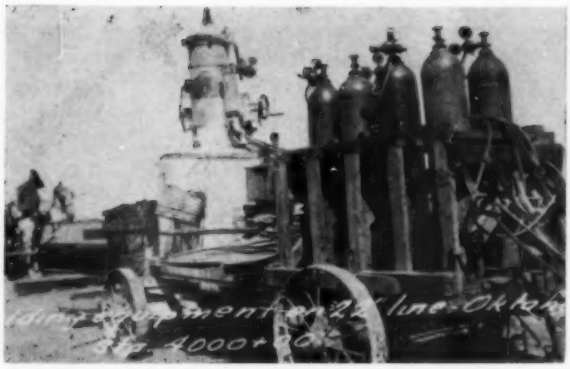
Tomorrow. There is little to criticize about today's bending machine, and until pipe specifications are increased it is doubtful that there will be radical changes in the machine.

Making 45-deg wrinkle bend.

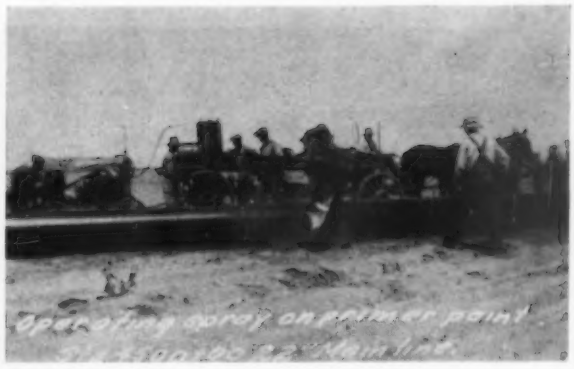


Early ditching machine at work.

LUFKIN MACHINE CO., LTD.,
Edmonton, Alberta



Early welding equipment on 22-in. Oklahoma line.



Spraying on primer paint, an early day operation.

Welding

Yesterday. Oxygen and acetylene welding was replaced with electric arc welding, starting in 1928. Biggest pipeline event in 1928 — was a 45-mile high pressure arc-welded line.

Today. We have automatic submerged arc welding on double-jointing equipment. We have X-Ray, Ultra-Sonic, Magnaflux, and dye penetrants for inspection. Welder skill is uniformly high.

Tomorrow. New rods of great promise are being developed, and knowledge of metallurgy is providing answers to difficulties. Weldable steels with 100,000 psi tensile are here.

Coating and wrapping

Yesterday. First pipe was coated by hand. Heating pots, etc., shown above right, were not efficient, and holidays were extensive. In 1938 traveling coating machine was developed.

Today. In addition to hot coating machines, we have dry plastics and recently a spray-on coating was developed. In wet weather, hot coatings slow or stop construction.

Tomorrow. There is talk of cladding pipe with corrosion resistant metal. Iron, rubber, nylon, etc., can be combined chemically, and there are plastics that make tough coatings.

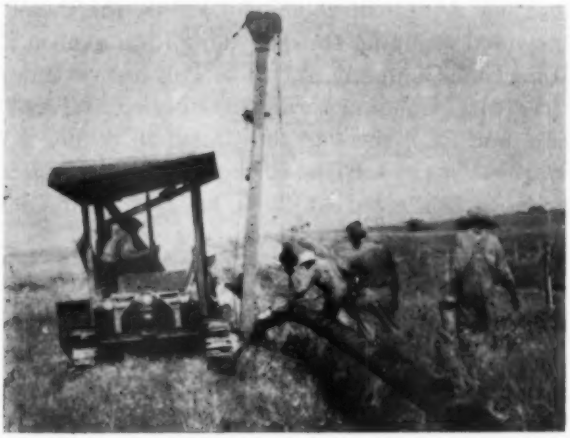
Lowering-in

Yesterday. Photographs show the lowering methods of 30 years ago. Slack loops were thought necessary.

Today. Contractors lower in pipe with sideboom tractors. Some lay directly into ditch. Slack loops eliminated.

Tomorrow. Most operations will be over the ditch; there's a possibility of extruding plastic pipe on R-O-W.

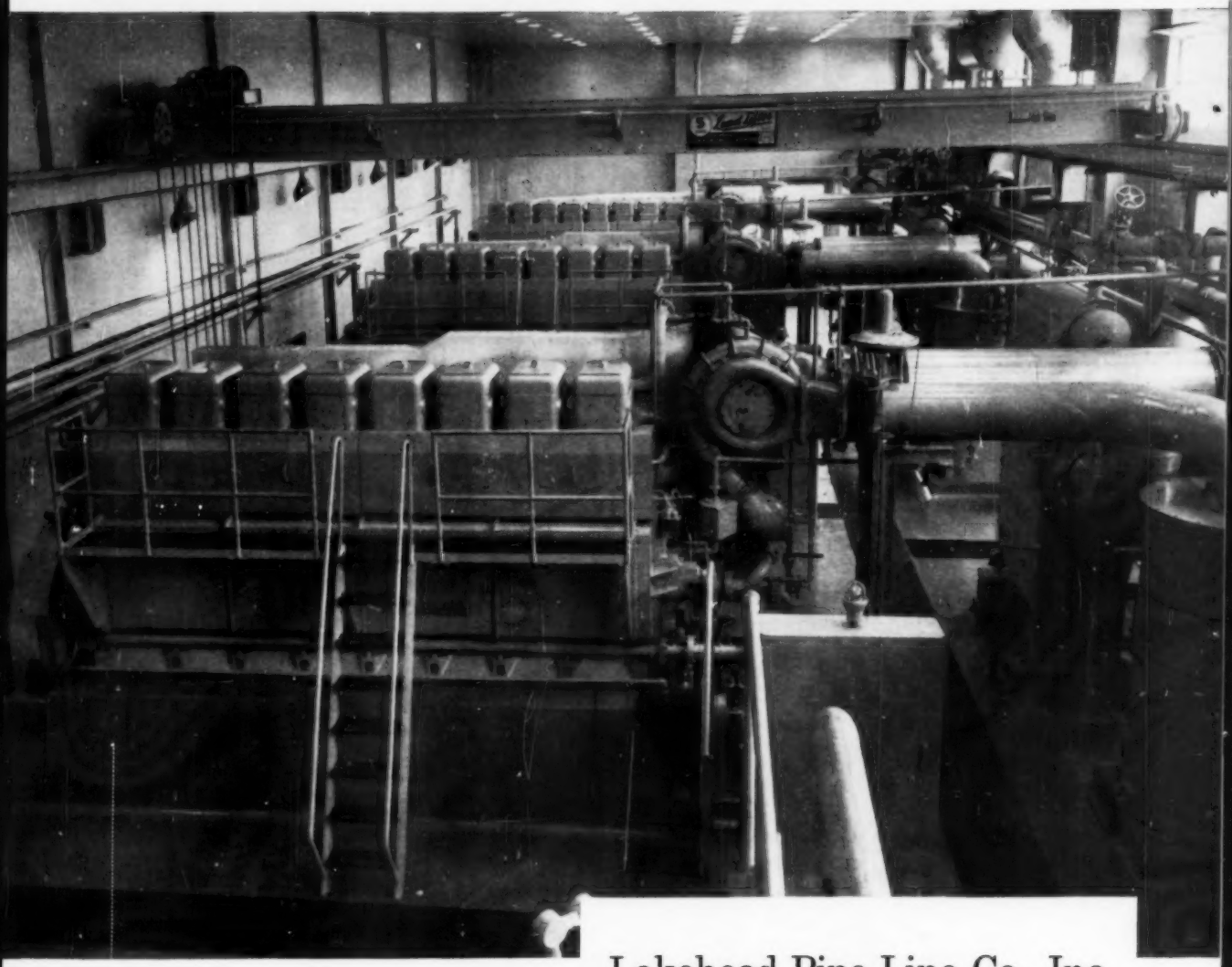
Acknowledgment. Digested from paper presented before Pipeline Division of American Society of Civil Engineers, Portland, Oregon, June 23-27.



Early sideboom tractor.

Lowering-in windlass.

NORDBERG ENGINES FOR PIPE LINES



Lakehead Pipe Line Co., Inc.

Fourteen Nordberg four-cycle engines, representing a total of 26,680 hp are in the diesel powered pumping stations along the Lakehead Pipe Line Company, Inc. line. This line extends from the Canadian border to Superior, Wisconsin, and from there to the Canadian border at Sarnia, Ontario. Eight of these *Supairthermal®* engines are rated at 2000 hp each and the remaining six, 1780 hp each.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

SEND FOR NEW PIPE LINE BOOKLET
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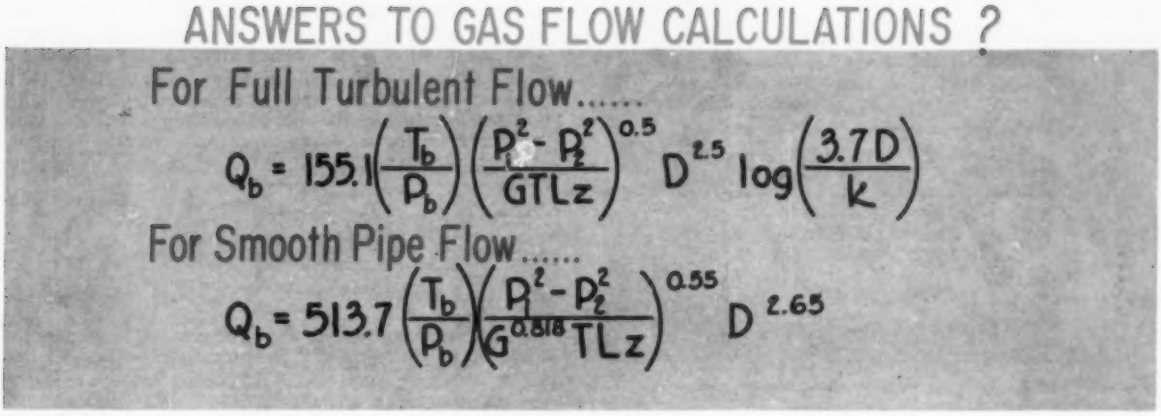
ANSWERS TO GAS FLOW CALCULATIONS ?
For Full Turbulent Flow.....
$Q_b = 155.1\left(\frac{T_b}{P_b}\right)\left(\frac{P_1^2 - P_2^2}{GTLz}\right)^{0.5} D^{2.5} \log\left(\frac{3.7D}{k}\right)$
For Smooth Pipe Flow.....
$Q_b = 513.7\left(\frac{T_b}{P_b}\right)\left(\frac{P_1^2 - P_2^2}{G^{0.818}TLz}\right)^{0.55} D^{2.65}$

FIG. 1.

Improved Gas Flow Equations

Flow phenomena in large-diameter natural gas pipelines

W. R. Staats and R. T. Ellington
Institute of Gas Technology, Chicago

Project NB-13, "Evaluation of Pipeline Efficiency Test Data," sponsored by the Pipeline Research Committee of American Gas Association was aimed at obtaining flow information on 12 to 36 in. pipelines. The data thus obtained and those of Smith[11] now give a relatively complete picture of flow behavior for high flow rates and low relative surface roughness not previously covered.

Here is a summary of these findings to date:

The General Flow Equation

A thermodynamic energy balance over a section of pipe yields the general flow equation:

$$Q_b = 38.77 \frac{T_b}{P_b}\sqrt{\frac{1}{f}}\left[\frac{P_1^2 - P_2^2 - 0.0375G\,\triangle h\,P_{avg}^2/zT}{GTLz}\right]^{0.500} D^{2.500} \quad \ldots\ldots\ldots\ldots (1)$$

or neglecting elevation changes:

$$Q_b = 38.77 \frac{T_b}{P_b}\sqrt{\frac{1}{f}}\left[\frac{P_1^2 - P_2^2}{GTLz}\right]^{0.500} D^{2.500} \ldots (2)$$

The latter form is the basis of most flow equations although the equations differ in the method used to express the *"friction factor"* or *"coefficient of friction,* f, or the *"transmission factor,"* $\sqrt{1/f}$. The transmission factor has been considered the more useful form in recent works, since flow rates are directly proportional to its value.

Bahavior of the Transmission Factor $\sqrt{1/f}$

What is the relationship between the transmission factor and environment characteristics, fluid properties, and flow variables? In literature there are two principal schools of thought concerning its dependence upon Reynolds number. Most authorities agree that the transmission factor ($\sqrt{1/f}$) depends only on N_{Re} when the latter is relatively low (smooth pipe flow). But when N_{Re} is high (fully turbulent flow), $\sqrt{1/f}$ is no longer a function of N_{Re} but reaches a constant value that is principally dependent on pipe diameter and the relative roughness of the pipe.

There is, however, disagreement over the form of transition between these two regions of flow. One group of authorities asserts that the transition is quite gradual, as shown by curve A, Fig. 2[2,3,4,5,7,10], the other proposes that the change is sharper as indicated by curves B, Fig 2[8,9,11,12].

The data of Smith et al[11] and those taken for this project favor curves B.

Theoretical developments by Prandtl and von Karman, based on boundary layer theory, resulted in the following equation for smooth-pipe behavior, which is known as the smooth-pipe law[11]:

$$\sqrt{\frac{1}{f}} = 4 \log N_{Re}\sqrt{f} - 0.6 \ldots\ldots (3)$$

Table of Symbols.

- D = Internal diameter of pipe, in.
- f = Friction factor, dimensionless
- $\sqrt{1/f}$ = Transmission factor, dimensionless
- FE = Pipeline flow efficiency, dimensionless
- G = Specific gravity of gas (Air = 1.0), dimensionless
- h = Elevation, ft
- K = A dimensional constant
- k = Internal pipe surface roughness, in.
- L = Length of pipeline, miles
- N_{Re} = Reynolds number, dimensionless
- P = Pressure, psia
- P_b = Base pressure, psia
- Q_b = Standard flow rate, std cu ft per day
- T = Average gas temperature, deg R
- T_b = Base temperature, deg R
- z = Average compressibility factor, dimensionless
- $\triangle$ = Finite difference operator
- σ = Standard deviation

This digest was prepared from a paper presented at the American Gas Association, Distribution, Production and Transmission Conference, May 5 through 9, 1958 in New York City.

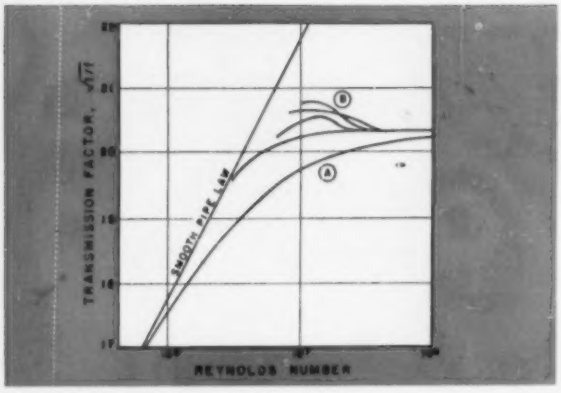

FIG. 2. Two conceptions of the form of the transition from smooth-pipe to fully-turbulent flow.

Until recent years, the most definitive data on the transmission factor in the fully-turbulent range, was that of Nikuradse,[8,9] which permitted modification of Equation 3 to give:

$$\sqrt{\frac{1}{f}} = 4 \log (3.7D/k) \quad \ldots\ldots\ldots \quad (4)$$

commonly called the rough-pipe law, in which k/d is termed the roughness ratio, the average height of surface protuberances divided by pipe diameter. The Nikuradse equation fits the data of Smith, et al,[11] and the data of this report well.

Investigation of pipe roughness

Summed Up:

1. **Of the experimental data available, Smith's seems to correspond most closely to those encountered in natural gas pipelines and under conditions that eliminate the effects of bends and joints.**
2. Laboratory observations support Nikuradse's evaluation of the constants in the equation for fully-turbulent flow.
3. Recently, commercial instruments have become available for making roughness measurements on surfaces. Conceivably it should now be possible to develop a correlation between *measured* and *effective roughness* and such work has been suggested.

Experimental data

Data were obtained for 16 lines ranging from 12 to 36-in. at several flow rates to permit the examination of the effect of N_{Re} on $\sqrt{1/f}$.

When the results were plotted (Fig. 3) it was not evident whether there is any distinct regularity in variation of $\sqrt{1/f}$ with N_{Re}. The apparent variation was examined from the standpoint of accuracy of data and the possible effect of random errors in measurement on calculated $\sqrt{1/f}$. Assuming that random errors in measurement have a normal distribution and the more significant errors are most likely to be in the measurement of pressure drop and flow rate,[1] the relative standard deviation in the transmission factor is:

$$\frac{\sigma\sqrt{1/f}}{\sqrt{1/f}} = \sqrt{\tfrac{1}{4}\left(\frac{\sigma\triangle P}{\triangle P}\right)^2 + \left(\frac{\sigma Q_b}{Q_b}\right)^2} = \sqrt{\frac{0.01}{(\triangle P)^2} + 0.000025} \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

Thus, the magnitude of expected error in $\sqrt{1/f}$ for any data point varies with the pressure drop magnitudes and the anticipated variation in $\sqrt{1/f}$ due to inherent errors in measurement can be calculated.

In order that the less accurate measurements should not bias the results, average $\sqrt{1/f}$ were calculated for each data set by weighting the individual values in proportion to the inverse square of the probable relative error in measurement. Thus, the less accurate data are weighted less heavily. Results (in Fig. 4) discount the apparent trends of first examination.

Another test of the variation in $\sqrt{1/f}$ is obtained by rearranging the basic flow equation, with elevation correction included, to give the form:

$$\frac{Q^2_b}{P_1 + P_2} = K(1/f)\left[\frac{P_1 - P_2 - 0.0375\,G\,\triangle h(P_1 + P_2)/4zT}{zTLG}\right] \quad \ldots\ldots\ldots\ldots\ldots \quad (6)$$

The left-hand term is subject to significant errors in flow rate only; and the right-hand term is subject to significant errors primarily in the pressure drop. A plot relating these terms should yield a straight line passing through the origin if the transmission factor is constant. A typical plat of this test is shown in Fig. 5.

Thus, it is evident that, within experimental error, the transmission factors obtained from these data are independent of Reynolds number. Although there may be some dependence at the lower flow rates tested, this relationship is of little concern in normal operation of gas transmission lines.

Analysis of flow equations

From the foregoing discussion it is clear that flow equations that properly represent pipeline behavior must have the following properties:

a. *For the fully-turbulent range,* representing most pipeline operating conditions, the flow equation should have a transmission factor that does not vary with

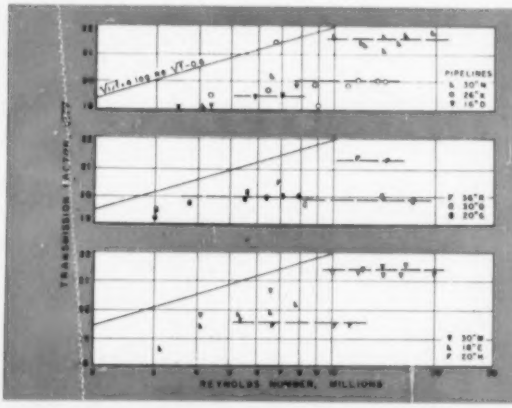

FIG. 3. Variation of transmission factor with Reynolds number of natural gas transmission pipelines.

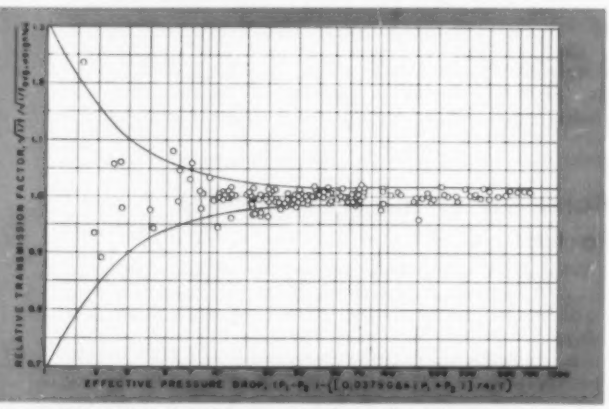

FIG. 4. Variation of transmission factors from the weighted average. (3 σ limits plotted for $\sigma Q_b = 0.005 Q_b$ and $\sigma \Delta P = 0.2$ psi)

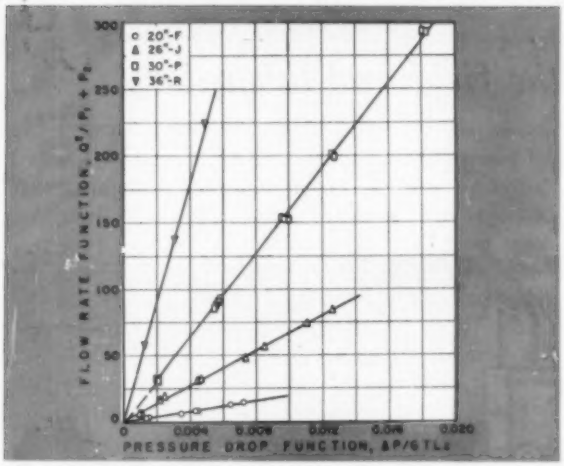

FIG. 5. Graphical test of transmission factor dependence on flow rate.

N_{Re}, but depends only on surface roughness and pipe diameter. The transition range also may be described by this equation with acceptable accuracy.

b. For smooth-pipe behavior, the transmission factor should depend only on N_{Re} and not on surface roughness or pipe diameter.

The most commonly used flow equations are as follows:

Weymouth:

$$Q_b = 433.49(FE)(T_b/P_b)\,[P_1^2 - P_2^2)/GTLz]^{0.500}\,D^{8/3} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Panhandle A:

$$Q_b = 435.87(FE)(T_b/P_b)^{1.0788}[(P_1^2 - P_2^2)/G^{0.8539}TLz]^{0.5394}\,D^{2.6182} \quad \ldots\ldots\ldots\ldots (8)$$

New Panhandle:

$$Q_b = 737(FE)(T_b/P_b)^{1.020}[(P_1^2 - P_2^2)/G^{0.961}TLz]^{0.510}\,D^{2.530} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

They do not describe today's operating conditions with the desired accuracy, and various "adjustment factors" or "flow efficiencies" are necessary. Unfortunately, these factors vary with N_{Re} and hence do not give entirely general results.

When Nikuradse's rough pipe law, $\sqrt{1/f} = 4 \log (3.7D/k)$ is substituted into Equation 2, we have:

$$Q_b = 155.1\,(T_b/P_b)/[(P_1^2 - P_2^2)/GTLz]^{0.500}\,D^{2.500} \log (3.7D/k) \quad \ldots\ldots\ldots (10)$$

This form is simple, but requires assignment of a value to the surface roughness, k. Since the magnitude of k at this time cannot be accurately determined for commercial pipe, it must necessarily be used as a "judgment factor," similar to the way the efficiency factor is now used. It is felt, however, that the above form for a flow equation shows more exactly the fundamental relationships governing flow behavior.

For the very low range of transmission flow rates that are represented by smooth-pipe behavior, an approximation to smooth-pipe behavior was made by fitting the relationship of the form, $\sqrt{1/f} = A\ N_{Re}^{B}$. This resulted in the expression:

$$Q_b = 513.7(T_b/P_b)\,[(P_1^2 - P_2^2)/G^{0.818}TLz]^{0.55}\,D^{2.65} \quad \ldots\ldots\ldots\ldots (11)$$

which agrees with smooth-pipe behavior within $\pm =$ over the range of Reynolds numbers from 60,000 to 7,000,000, with the gas viscosity assumed as 8×10^{-6} lb-mass/ft sec.

The authors emphasize that these represent only preliminary efforts to devise improved flow equations, and this work is being continued.

Conclusions

1. Analysis of this field test data shows that, within experimental error, the transmission factor $\sqrt{1/f}$ is independent of Reynolds number for the flow rates usually encountered in pipeline operation.

2. Over the range of flow rates studied, the variations in transmission factor lie generally within the range ascribable to random errors in flow rate and pressure measurement. Only 3 of the 80 data points obtained for pressure drops exceeding 30 psi show variations from the mean of more than 1.5 percent. The standard deviation in transmission factor for higher pressure drops is of the order of 0.7 percent.

3. Examination of the available flow data for conditions representative of those encountered in natural gas pipelines indicates that:

a. Smooth-pipe behavior seldom occurs in large-diameter natural gas transmission lines.

b. The transmission factor is independent of Reynolds number for a significant range of turbulent flow rates which may be termed the region of fully-turbulent behavior. This range characterizes most natural gas transmission pipeline operating conditions.

c. There is a range of flow rates, between those described above, for which data do not follow a definite pattern and the transmission factor depends on both Reynolds number and surface geometry in a complex manner that is not predictable from present information.

4. For natural gas transmission design it is concluded that:

a. For the fully-turbulent range, representing most operating conditions, the flow equation should be based on a transmission factor that does not vary with Reynolds number, but depends only on surface roughness and pipe diameter.

b. For smooth-pipe behavior, the flow equation should be based on a transmission factor that depends on Reynolds number and not on surface roughness or pipe diameter.

c. The transition range between smooth-pipe behavior and fully-turbulent behavior can be described with acceptable accuracy by extending the relation for fully-turbulent flow to a sufficiently low Reynolds number that it intersects the relation for smooth-pipe behavior.

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DEVELOPMENTS TO WATCH

from the field and laboratory

A look ahead to 2000 AD

AN AGE OF FARMERS and miners of the seas is foreseen in the year 2000 by H. J. Rand, Rand Development Corporation president, who gives his predictions for the future in the IBM publication *Think*.

Pointing out that the sea may well be the source of isotopes for controlling, harnessing, and practical application of atomic fusion (control of the H-bomb reaction), he estimates that a cubic mile of sea water may contain sufficient isotopes to satisfy the world's annual energy requirements at that time. Concomitantly, processing of the water will yield gold, silver, iodine, bromine, tungsten, and magnesium, as well as hundreds of valuable chemicals now taken from the air, and Rand believes that sea derivative foods now unknown will be farmed to augment the food supply by an expanded population.

Half of man's oil consumption in all history, he states, has taken place in the last 25 years (more fuel is used by a SAC bomber in one mission than was used by most of our entire Air Corps in 1918), and he sees 2000 AD as a year when atomic energy largely will have supplanted what remains of fossil fuels such as coal, oil, and natural gas as a source of power.

Calling attention to the progress made in magnetic tape operation of complex machinery, he further predicts computer and photoelectric sensing devices, plus tape programing, enabling farmers to monitor the cultivation, plowing, sowing, and reaping in a number of fields simultaneously.

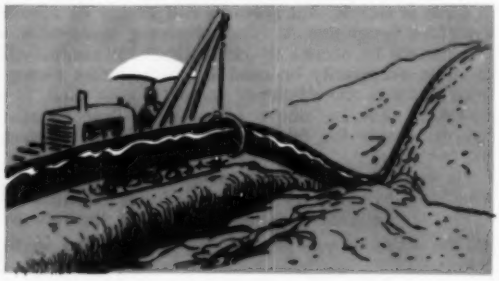
"A farmer, for example, will be able to sit at the console of a television receiver and keep tract of machines in half a dozen fields unattended by any human hands except the ones that control the electronic equipment."

Among other probable developments by the turn of the century: Spaceships traveling at a speed approaching the speed of light; a whole new family of materials "now unknown to man or even to nature" by processes such as that used by General Electric to produce synthetic diamonds, and the processing of waste and sewage materials for a variety of human uses.

Bend, weld new PVC coated steel

A NEW PLASTIC COATED STEEL product said to have a number of competitive advantages has been brought out by two British companies. The material, named Stelvetite, can, says one company spokesman, be bent or seamed, deep-drawn or welded, all without damage to its polyvinyl chloride coating.

Developed by John Summers and Sons, a British steel company in collaboration with BX Plastics, the bonded plastic sheet is described in *Barron's* as being five to seven times as thick as paint, virtually scratchproof, and capable of being embossed with any number of designs. It is usable for nearly every purpose now served by sheet steel, whether for automobiles, refrigerators, washing machines, or metal furniture. No painting is required, and the material matches the



cost of finished sheet, but is cheaper per square foot than such products as anodized aluminum or laminated plastics.

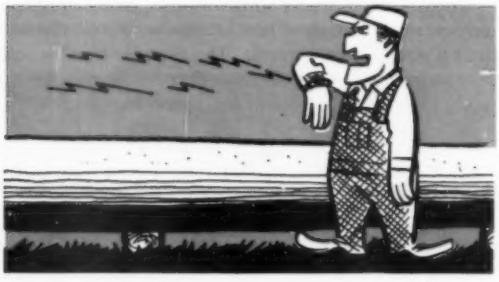
Present output is at the rate of 500 tons a week with expansion due if expectations of the manufacturers are fulfilled.

Stretchable paper for pipelines?

FIRST LICENSE has been issued for commercial manufacture of a new stretchable paper invented by Sanford L. Cluett, who also invented the Sanforized process for textiles. The plant, situated in Charleston, South Carolina, will use a $25,000,000 paper plant to turn out the product, said to be tougher, more enduring, and to have 20 percent more stretch than regular kraft paper.

Initially the paper will be used in grocery bags and similar packaging materials. Envisioned as a future possibility: Use of the new paper for disposable clothing, outer wrap for pipelines.

New electronic device rivals transistor, vacuum tube



A NEW ELECTROCHEMICAL DEVICE nicknamed "solion" bids to rival both the vacuum tube and the transistor as a basic electronic component.

Where the vacuum tube works on the principle of movement of ions (electrically charged atoms or molecules) in gas or vacuum, and the transistor by ionic circulation in a solid, the solion features ions flowing between electrodes in an iodine solution. Since the solion is highly sensitive to changes in outside conditions, the flow can be stimulated and varied by temperature, pressure, light, sound, or acceleration changes. Thus, in certain applications, the device may well be more selective, sensitive, and efficient than either of the existing devices.

Developed by the Naval Ordnance Laboratory, the solion is expected to reduce the size and cost of, as well as greatly simplify, electronic systems, replacing bulky and complex circuits with a package weighing but a few ounces. Future civilian usage might involve heat control, furnace regulation, pressure indication, and operation of burglar and fire alarms.

Transistorized land mine detector for line location

NOW TRANSISTORS have lightened the mine-sweeping chores of the Army foot soldier who was, you'll recall, previously required to inch over touchy ground with a cumbersome device that made him a sitting duck for hostile marksmen. This relief comes as the result of a transistorized detector developed for the Army by Texas Instruments, Inc.

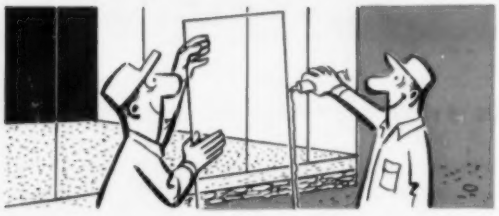
Featuring greatly increased sensitivity and a much longer battery life, the detector is cut down in size for the operator's convenience. In fact the detector has been so thoroughly miniaturized that all parts except the antenna can be carried beneath the operator's clothing — an important consideration where such a detector is required in arctic regions. It is, as well, fungus-proof for employment in tropical areas.

Flexible ceramics

A UNIVERSITY OF CALIFORNIA research team has devised laboratory methods of treating certain highly brittle materials so that they can be bent without breakage. They are flexible ceramics. Present disadvantages of metals are that they become virtually useless at temperatures above 1700 F. Ceramics, though unaffected by temperatures as high as 3000 F, have thus far proved hopelessly brittle.

Should the California experiments with flexible ceramics prove further successful, we may well have achieved a giant step.

New glass cement for super glass



CORNING GLASS WORKS has announced development of a Pyroceram-brand cement capable of sealing most glasses, as well as glass to ceramics and metals, and metals, such as chrome and nickel stainless steels, to metals. Sealing range of the cement is given as 400 to 450 C.

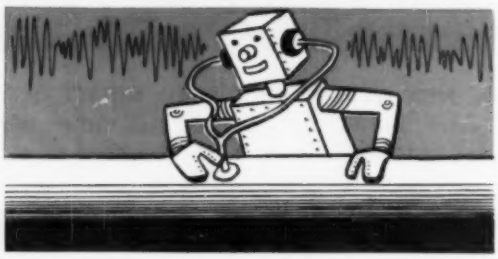
Having a toothpaste softness in its glassy state, the cement may, with short heat treatment, be transformed into a strong glass-ceramic. The ceramic bond is said to be stronger and harder than the parts joined in most glass-to-glass seals, even at high temperatures.

Ultrasonic waves will find greater use on pipelines

HIGH FREQUENCY SOUND WAVES, which have proved their value in the inspection of many pipeline compressors, etc., are now being used in degreasing and cleaning of equipment and parts as well as for control of liquid in tanks. Yet these are but a few of the new applications for this miracle process not even taken seriously until recent years. Elsewhere, ultrasonic waves, dubbed "silent sound," are doing everything from aging wine to decontaminating radio-active parts.

Ultrasonic vibrations (in general, sound waves vibrating more than 18,000 times a second) for commercial use are usually produced by the employment of an instrument called a transducer, which shoots electric current through either nickel rods or quartz or ceramic crystals. The electrical energy is thus converted into mechanical vibrations, which are exactly like sound vibrations except that their frequency is too high for the ear to detect.

When used as an inspection tool, the sound waves are beamed into solid material and, since they do not easily cross such air barriers as cracks, reflect back when such cracks, corrosion, or other defects are encountered. The remaining waves reach the opposite end of the material before they too are reflected back to the measuring instrument. By comparison of the time required for the waves to make the round trip, flaws may be accurately located. One metals fabricating company has estimated that the sound method has saved them more than $1 million in damage in shutdown time over a two-year period by advising early replacement of defective parts. Branson Ultrasonic Corporation and Sperry Products, Inc., are currently manufacturing inspection tools.



For cleaning purposes, parts to be cleaned are immersed in a liquid solvent through which sound waves in the 300,000 to 1,000,000 cycles-per-second range are sent. The silent vibrations shake free all dirt, oil, and grease particles from tiny openings.

A unit to control the flow of liquids is now being offered commercially. This device reacts upon contact with liquid and can be hooked up either to activate a cut-off or turn-on valve.

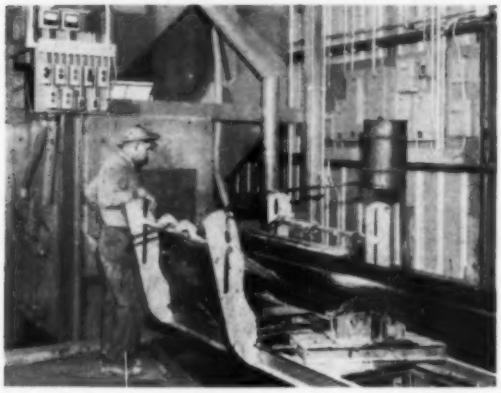
Still another use of silent sound has been found in the welding and bonding of hard-to-join materials. In the case of aluminum, for example, the waves make possible previously difficult soldering by removing the metal's oxide film.

Thus, ultrasonic sound continues to demonstrate its versatility in every direction, as it is applied in therapy units, degassing of beer prior to capping of bottles, carving or drilling hard-to-machine materials, cleaning of delicate camera lenses, and cleaning the inside of hypodermic needles. One appliance manufacturer is even investigating the possibilities of an ultrasonic dishwasher.

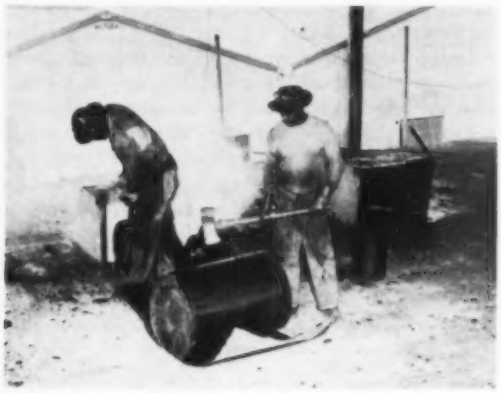
Automation comes to pipe coating

Automation has come to pipe coating — and, as is usually the case when automation steps in, time and labor savings result. The Sid E. Culbertson Company (SECCO) of Houston, Texas, has a new plant that virtually spews out coated pipe, ready for loading onto rails, barges or trucks that service the company's yard.

Several inventions are involved in the new process — chief among them is the plug that joins the pipe ends, protecting the bevels during the coating operation. The crew manning the plant today number about ⅓ of former forces, yet production is greatly increased.



Pipe feeds into the SECCO plant from outside racks, goes through grit blaster at left and then receives primer coat.



Coal tar and asphalt enamels enter underground melting pots that maintain even temperatures until applied to the pipe — automatically.

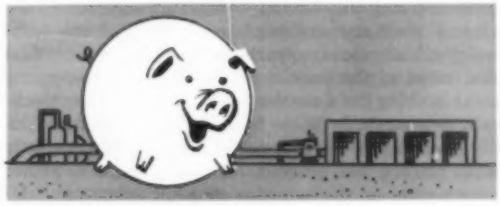
Primed pipe is cured in room that carefully controls humidity. Here it is feeding into machine at left that applies the coating and wrapping.

Coating and wrapping equipment operates automatically at high speeds. Note the tachometer on car at left which shunts back and forth with each joint.

New spherical pig for product lines

A LIQUID-FILLED, rubber sphere is designed to operate in all products lines where an intermediate seal to transmit pressure is desired. Especially designed for **product separation** and **calibration of meter loops in products lines,** the sphere also has been found excellent for water, product removal, etc.

Over four years of development has gone into the design of the spheres. Extensive laboratory and field tests, in operating products lines, has proved that the spheres will withstand runs of 500 miles and more before wear becomes excessive. In addition the sphere lends itself readily to automation around compressor or pumping stations. It is flexible in use, and will follow the flow through sharp radius bends, through tees, etc. Handling difficulties are minimized as the spheres require no maintenance or assembly other than proper sizing of actual operating diameter, which



is controllable in the field. This adjustable sizing also allows the user to compensate for wear, which effectively increases the life of the sphere. This is possible without any loss in accuracy.

Sizes presently available are (nominal pipe size): 4, 6, 8, 10, 12, 14, 16, and 20 in. Additional sizes are being designed.

Small portable diesels are here

HIGHLIGHTING A DRIVE to give the diesel engine a high power-to-weight ratio, Petters, Ltd., of England has brought out a new range of lightweight, portable, aircooled diesels adaptable for a variety of uses for which the engine was formerly too heavy. They can be employed on cultivators and balers; for pumps, generators, and rotary compressors, and for automotive and marine applications.

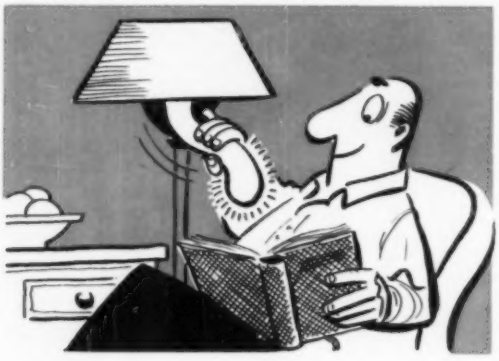
Tested under field conditions for two years and based upon thousands of hours of operating experience, the present production models come in a range that includes 1, 2, 3, and 4-cylinder engines, which provide 6.25 to 25 bhp at the comparatively high speed of 3000 rpm. Direct injection is used for easy starting, and the range features interchangeability of the wearing parts.

Distributed in the United States through Brush Aboe, Inc., the engines are fitted with standard SAE bell housings and unified threads. Among other possible uses noted by the manufacturers: Concrete vibrators, 3-kva alternators, mobile sawbenches, welding sets, paint sprayers, trenching machines, pipe cleaning machines, and winches.

Light bulbs that bend

HOME AND COMMERCIAL ILLUMINATION by window shades or drapes may be in the offing as the result of a new flexible "light" bulb recently developed by the lamp division of Westinghouse.

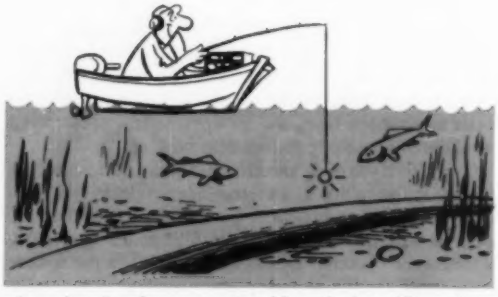
Researchers there have devised glass, metal, and plastic panels that are phosphor-coated and treated to conduct electricity when power is applied. The phosphors can be applied to plastic, nylon, and steel mesh, and hint of future lamps or such flexibility that the user could bend them into any shape desired. Additionally, light intensity can be increased or decreased, and the lamps can be produced in various colors. Although not yet commercially available, the lamps could lead to lighting developments even more revolutionary than the advent of neon.



Will sonic fish tags help locate underwater lines?

WHETHER THEY LIKE IT OR NOT — and there's no reason why they should — assorted delegates of the animal world are very much in the thick of new technological advances, apparently oblivious to the fact that some of the tests in which they're participating mean nothing but a shorter road to the chopping block.

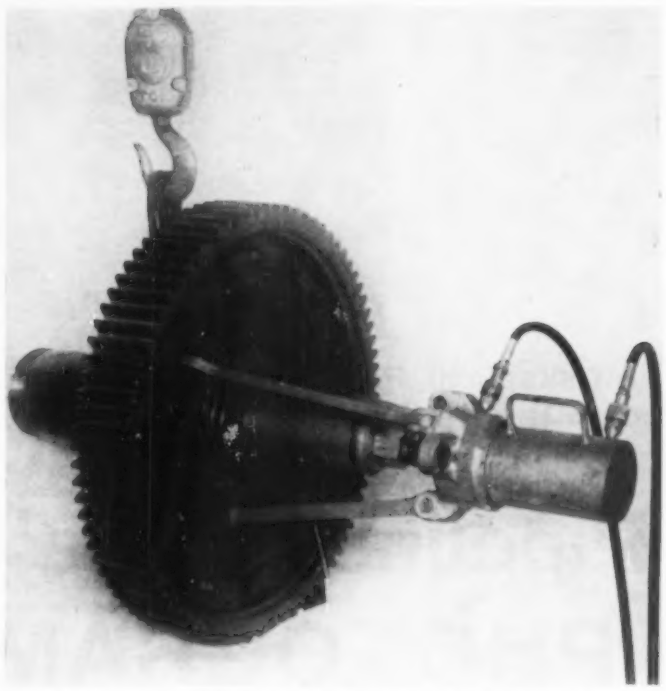
If new methods in use by the U. S. Fish and Wildlife Commission are successful, salmon will have little more privacy than goldfish, for in a program to gather information on the behavior of adult salmon in relation to Columbia River dams, electronic equipment development by Minneapolis-Honeywell Regulator Company is being used to follow and outline their habits. Selected fish are fitted with tiny (two gram) underwater ultrasonic transducers or sonic "fish tags" that put out sound waves trackable within 800 ft. Once the signals are received by boat-borne, self-positioning, directional echo-ranging receiving systems, the fish are pin-pointed, whereupon tracking devices "home" on the tag, emitting ultrasonic impulses whose echoes report subsequent movements of the fish. The equipment can also be used, says the manufacturer, to provide information on other fish and aquatic animals.



When and How to Replace Anti-Friction Bearings

Bearings are often ruined or discarded needlessly. You can save money by following these few service suggestions

C. V. Borho,
Service Engineer
Caterpillar Tractor Company



Care should be taken to avoid damaging bearings or their mating parts during removal. Improvised tools often do the job, but hydraulic pullers such as the one shown in this photograph, or an arbor press, are far safer and more efficient.

THERE ARE five basic types of anti-friction bearings. Each has a specific application although uses often overlap. The choice of a bearing used in original equipment is, quite naturally, up to the designer of the assembly of which it is a part. When replacement becomes necessary, it is very risky to use *any* bearing just because it fits a shaft and bore. To guard against this possibility, consult the manufacturer's up-to-date parts catalog and install bearings by part numbers. Installing a "will fit" bearing is asking for trouble.

Foreign matter and lack of lubrication are the most frequent reasons why bearings fail. When installing a new bearing handle it with care. During manufacture and storage, bearings are protected with a coating of lubricant and packed inside a paper wrapper. This lubricant should not be washed from the bearing. It is virtually impossible to wash a bearing as clean as it was when the manufacturer lubricated it. After all, bearings are made in dirt-free surroundings.

Keep bearings in their original packaging until you are ready to install them. Touch the bearing as little as possible because prespiration starts corrosion. Use clean lint-free rags. Never use cotton waste to wipe a bearing or its mating surfaces. Cleanliness counts.

Serviceable used bearings also require special handling. Take time to examine the assembly. Countless bearings have been ruined because someone didn't know how to take the assembly apart and put it back together. Bearing pullers or an arbor press are handy items to have when removing or installing bearings. Improvised tools will work, but it is essential that considerable care be taken to avoid damage.

When a piece of equipment is taken apart, the bearings should stay with the member to which they are tightly fitted. In the case of bearings that are made with separable parts – inner ring, outer ring, and ball or roller assembly — both rings often may fit tightly. Always determine whether it is best to press or pull on the race or cup when the bearing is tight on the shaft or bore. Press or pull straight and square to keep the ring from cocking. A cocked bearing can easily score the shaft or housing or cause damage to the bearing itself. Never press or pull against bearing shields or separators. Remember that in most cases a bearing *can* be reused — if you remove it correctly.

After the bearing has been removed, wash it in a solvent until it is absolutely clean. Next, determine whether it is still serviceable. Here are the reasons for replacing a bearing:

1. Broken or cracked rings.
2. Dented seals or shields.
3. Cracked or broken separators, balls or rollers.
4. Flaked areas on balls, rollers or raceways.
5. Bearings that have been overheated. Overheated bearings are generally darkened to brownish blue or blue black.
6. Bearings with dented or "brinelled" raceways.

If the bearing is determined to be serviceable, apply a coating of light grease or other protective lubricant. Rotate the bearing slowly to make sure all surfaces are completely lubricated. Wrap in clean paper with the bearing's identification clearly marked on it. This practice will eliminate unnecessary handling.

In summary, remember these key points:

Don't throw away serviceable bearings.

Use the *right* bearing as listed in the manufacturer's current parts catalog if replacement is necessary.

Keep bearings clean, exercising care during installation and removal to avoid damage. ★ ★ ★

P 615.061

FIG. 1. Targets were of two shapes to identify the various points marked. This marking is for a horizontal angle point. Other points were marked with a "V."

At first skeptical, Pacific Lighting found it took 60% less time and cost 45% less to make a

Pipeline Route Survey by PHOTOGRAMMETRY

Maurice E. Fuller
Chief Engineer
Pacific Lighting Gas Supply Company

IMPROVED TECHNIQUES AND TOOLS for getting the job done are constantly available. Just keeping informed regarding what's new is a considerable undertaking. Nevertheless, it is our obligation to examine, select, and use the new techniques and tools that will get the job done better.

A new technique recently used by Pacific Gas Supply Company was photogrammetry to survey a pipeline route. By this method lengths and bearings of lines were determined without putting surveyors in the field with chain and transit to measure the relationship between points along a right-of-way.

Typical of others in the industry, the company for some time had recognized the usefulness of aerial photography in selecting a pipeline route, but the next step of an aerial cadastral survey was not taken so readily. There was question regarding its accuracy. Being a departure from the conventional methods it was not known whether all the information that can be secured by a ground survey party could be obtained by photogrammetry.

The science of photogrammetry was developed and accepted in Europe at an earlier date than in this country. This is perhaps natural because interest by governments in setting national boundaries fostered development of precise surveying methods. Also, with the intense development and use of land areas over the years, control points with precisely determined coordinates are more numerous than is the case in the United States.

European industries and governments have conducted tests that demonstrated that accuracy necessary for cadastral surveys can be obtained by photogrammetry. The Swiss Department of Cadastral Surveys conducted tests flying at elevations ranging between 3500 and 10,000 ft above ground and achieved results with a mean error of ± 6.6 in.

In the spring of 1957 Pacific Lighting Gas Supply Company had selected a preliminary route for a 34-in. gas pipeline, approximately 82 miles long, to be installed between Newhall and North Coles Levee, California.

The route was marked on a series of aerial photographs obtained from the United States Department of Agriculture. Stakes had been set at horizontal angle points. A study of the preliminary route indicated that approximately 100 parcels involving 90 owners would be crossed by the pipeline. Ownership was varied, ranging from small privately held parcels to large ranches where monuments were infrequent.

Elevation of the route reached a maximum of 4500 ft, near the midpoint and dropped to about 1000 ft at each end. Where the route had not been put under cultivation it was lightly covered with oak woods or covered with dense brush 8 to 10 ft high. Terrain along the route is classified as:

Terrain	Miles
Level, no high crops or brush	40
Rolling hills, lightly wooded or brush covered	12
Steel hills, brush covered	25
Rugged mountains, brush covered	5

Paper presented at Pacific Coast Gas Association Transmission Conference, San Diego, California, May 1958.

It was recognized that a survey by conventional field crews would encounter difficulties. Unless more than two crews could be put on the ground, it was estimated that 42 weeks would be required to complete a field survey. Putting more crews on the job could be expected to shorten the time required, but would involve the increased burden of coordinating their work.

Because of the rugged terrain, there was concern over the accuracy that could be attained by ground parties. Suitable control monuments were at such a distance apart that it was felt considerable error might be introduced in a traverse between those points.

Objective of Survey

From the company point of view the survey method selected had to be one that would permit accuracy so there would be no future requirement to relocate the pipeline or procure additional right-of-way because of faulty survey work. Essential features necessary to accomplish this were:

1. **Legal description must positively identify the route for title purposes.**
2. **Legal description had to contain all necessary information for a competent surveyor to locate the route on the ground.**
3. **Route described must be continuous.**
4. **Fee ownership of each parcel traversed had to be determined together with approximate footage of right of way on each.**

Requirements of the job and field conditions indicated that consideration should be given to photogrammetry for the survey. Therefore, the company took bids for the work to be done by that method with three major requirements:

1. Any point along the route was to be located within five feet of its true position.

2. Legal descriptions and drawings were to be completed 16 weeks after start of work.

3. Lambert coordinates were to be determined for each horizontal angle point in the pipeline route, each control monument used, and each vantage point, using photogrammetric equipment capable of first order accuracy.

What Lambert System Does

The Lambert system referred to is a method of constructing maps, representing with limited distortion the curved surface of the earth as a plane surface. Distortion, if not corrected, introduces at worst, a linear error of 1 part in 10,000. Since the relationship between the earth's surface and the plane of a Lambert grid is a precise one that can be described mathematically, the distortion can be eliminated if that accuracy is necessary.

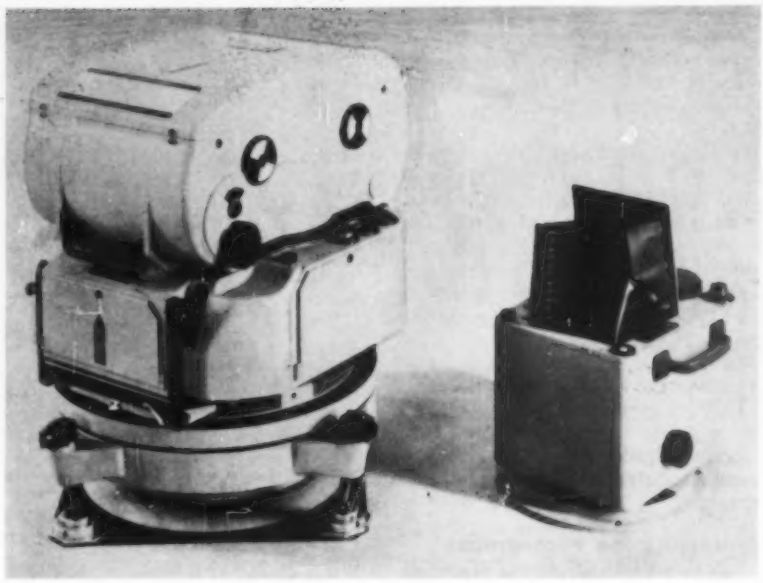


FIG. 2. The camera used was a Zeiss RMK 15/23, having a lens that produced nearly distortion-free pictures.

California is divided into seven zones under the Lambert system. These zones do not exceed 157 miles in the north-south dimension to keep the distortion within the limits described above. The fifth zone covered all of the area traversed by the proposed pipeline and provided a continuous network of coordinate values that avoided the usual problems of tying the survey into a series of unrelated surveys of record.

The job was awarded to Pacific Air Industries of Long Beach, California, who were to perform the aerial photography and photogrammetry. They subcontracted the work of establishing ground control, preparing legal descriptions and drawings to Aerial Control, Inc., of Woodland Hills, California. Under the agreement made with the surveyor, the company was to:

1. Set targets on horizontal angle points.

2. Select vantage points at high locations (from which ground crews would later set construction stakes) and mark them with targets.

3. Provide a strip map of the approximate pipeline route.

4. Procure lot book reports showing fee ownerships along the route.

5. Provide parcel maps showing the approximate location of the pipeline route and the fee owners.

6. Provide a representative to work with the surveyor, identifying targets and making final decisions when required regarding changes in the route.

Preliminary work done by the surveyor prior to photography included:

1. Select U. S. Coast and Geodetic Survey monuments to be used in establishing ground control.

2. Where such monuments were remote from the pipeline route, set temporary monuments adjacent to the route with third order accuracy or better.

3. Select, locate, and target the points of record adjacent to the preliminary route.

Targets used had two shapes to identify the various points marked. At horizontal angle points in the route an "X" was placed on the ground with its center superimposed on the hub which marked the angle point. All other points to be photographed were marked with a "V" placed with its inside edges intersecting on the hub. Frequency with which vantage points were set was governed by the terrain. This varied from eight per mile in a rough section to about two per mile in level country. Monuments were set so that approximately 30 miles of the route could be photographed in a single flight. It was found that the optimum flight length will be governed principally by the permanence of the targets.

Targets were made with various materials selected for their high reflecting value. The most satisfactory material was plaster of Paris, which was spread on the ground in the shape desired and sprinkled with water so it would set up. In windy locations, however, the plaster of Paris would blow away or lose definition before it could harden. In such cases, aluminum foil on Kraft paper backing was used to good advantage. Experience showed foil would reflect a

blur of light unless it were crinkled. The foil was held in place with rocks or with wooden frames. Targets were made not less than 12 ft across with 3 ft the minimum width of each leg (see Fig. 1).

The crew used by the surveyor during aerial photography included one photographer in addition to the pilot. A Zeiss RMK 15/23 camera, shown in Fig. 2, having a lens that produced nearly distortion-free pictures, was used. It is capable of shutter speeds up to 1/1000 second and has a magazine capacity of 570 exposures on a 9 in. by 9-in. negative. Pictures were made at a scale of 1 in. = 1500 ft with a 60 percent overlap resulting in a net gain along the route of about 5400 ft per picture. Flights for this survey were at approximately 9000 ft above the terrain.

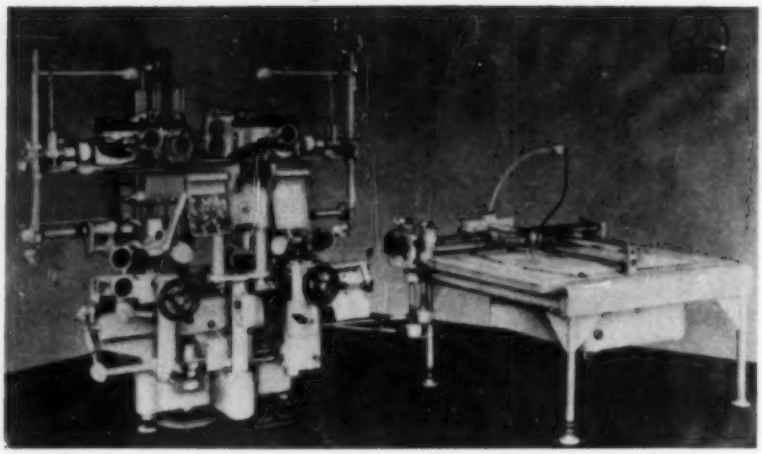


FIG. 3. Processing of photography was with a Zeiss C8 stereoplanigraph.

Processing the Photography

Upon completion of the flights no further field work was required to write legal descriptions and make drawings. Processing the photography to accomplish this was done with a Zeiss C8 stereoplanigraph, shown in Fig. 3.

Prints of successive exposures were made on glass plates and mounted in pairs called "models" in the stereoplanigraph for a stereo view of the area photographed. The stereoplanigraph has three dials, which indicate "X" and "Y" ordinates on a horizontal plane together with "Z" ordinates for vertical values. After corrections were made in the machine for any deviation of the camera at the instant of exposure from a straight and level flight, it was ready to operate. When it is in proper adjustment, a pinpoint of light can be moved by the operator to any point on the model with each dial constantly showing its ordinate for that point. Work on each model was started by observing the machine coordinates when the light was placed on ground control monuments near opposite edges of the model. These machine values were then checked against the coordinates determined by the ground control party. After a satisfactory check was made, the operator placed the light over each survey point in that model and recorded the machine coordinates for each position.

The machine coordinates were then converted to Lambert coordinates by computations that are detailed but can be turned out quickly with an electronic computer. These coordinates were used to calculate the bearings and lengths between individual points along the pipeline route and to determine ties to points of record. With this information the surveyor was able to write legal descriptions from one end of the route to the other.

The approximate length of right-of-way on each landowner was determined by scaling from drawings made by photogrammetry. Exact lengths were not necessary since the footages were to be used in negotiated payments for rights-of-way and crop damage. Furthermore, the company did not care to participate in any disputes that may have existed over boundary locations.

In addition to the legal description the surveyor did the following work:

1. Made tracings showing the centerline of the route from which prints were made for right-of-way documents.

2. Made tracings of the route centerline and adjacent culture. These tracings will be base drawings for atlas sheets, which will be completed by company draftsmen.

3. Made strip contour maps and profiles at selected locations.

4. Furnished an uncorrected aerial mosaic of the pipeline route on film suitable for blueprinting.

How Mosaics Were Used

The aerial mosaic was made in sheets corresponding to the area shown on each atlas sheet. They will be used in atlas books so that a matching drawing and photograph will be on opposite sides. Photos were supplied contractors bidding the pipeline installation to assist them in locating the route, planning access to the job site, etc. Also, in negotiating the rights-of-way the aerial photographs were found to be useful because landowners could readily recognize their land and the proposed route across it. They proved to be a popular item with the landowners, resulting in a number of requests for photographs. The cost of providing them was money well spent for good public relations.

In order to keep reproduction cost of the aerial photographs low, contact prints of the photography were mounted in sequence on a panel and then photographed. The picture was enlarged to a 1 inch = 600 ft scale and a positive print made on the emulsion side of acetate safety film. The route of the pipeline was then inked on the opposite side of the film. Although this process sacrifices some of the detail that could be achieved by a photographic process, the clarity of blueprints from the film is sufficient for all uses anticipated. The film is capable of erasure and re-inking so the company can maintain an up-to-date photograph of the pipeline route. These films will lend themselves to drawing notations of developments such as clearing or grading land adjacent to or over the pipeline.

M. E. Fuller *was graduated from the University of California at Berkeley with a BS in civil engineering in 1942. Immediately after graduation and until January 1944, he worked with the Pacific Electric Company as a junior engineer. From January 1944, to July 1946, he served in the Naval Reserve with the rank of Lieutenant, JG, working in Aviation Ordnance. In July 1946, he started working with Pacific Lighting Gas Supply Company as division engineer, and in 1950 was promoted to supervising engineer. On June 1, 1957, he was appointed chief engineer.*

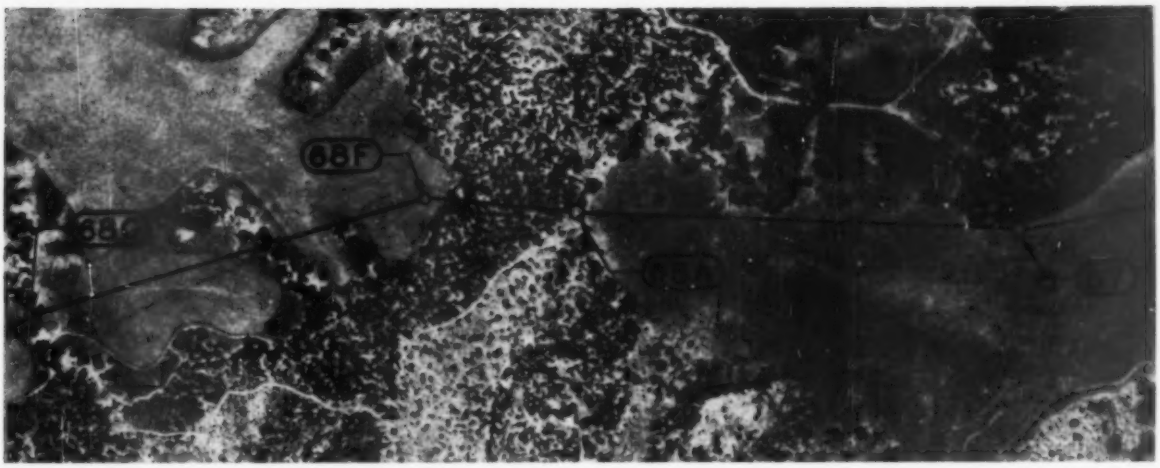


FIG. 4. Example of location map made by making print on acetate film and inking line route and location numbers on reverse side. Film can be erased so that corrections can be made to keep map current at all times. Print is also valuable in helping both right-of-way agent and landowner to identify property.

Role of Ground Survey Parties

Just prior to the start of construction, ground survey parties set intermediate stakes on line between the horizontal angle points. In brush country this crew worked with the lead tractors. In this way all brush clearing was done by heavy power equipment rather than by hand ahead of a preliminary survey party. Vantage points proved to be most valuable in this work. Setting stakes on long tangents that exceeded transit sight distances was expedited by using the Lambert coordinates of vantage points and calculating the offset to the centerline of the route.

After the pipeline was installed, the stationing of intermediate facilities such as valves, contact points, drips, etc., was determined by a ground survey crew. At the outset the party chief was suspicious of the work done by photogrammetry and therefore made precise measurements of the first courses installed. By photogrammetry the first tangent was 1054.01 ft long. The chained length was 0.15 ft longer. The second tangent of 706.90 ft was chained with a result 0.07 ft shorter.

One should not attach too much significance to these results because at the altitudes flown and the scales used this order of accuracy could not be expected. It is more likely a coincidence, but it does provide solid evidence that good photogrammetric work was done.

More typical was a 7-mile long tangent that was chained at 0.8 ft more than the photogrammetric length. In 35 miles of pipeline installed across the floor of the San Joaquin Valley, the largest discrepancy found was 4.3 ft, but a difference in the opposite direction of 3.9 ft was found in the next course. The party chief is now inclined to suspect the field work if discrepancies are noted. At the present time about one-half of the as-built survey is completed and there has been no need to adjust the photogrammetry results.

Eight miles of the as-built survey has been completed through hilly terrain. It was found that the probable difference in photogrammetric and chained lengths was 1.2 ft. A comparison of these lengths is shown in Table 1. The length of Course No. 8, which shows the greatest difference was made on a 45-deg slope where field measurements were most susceptible to error. It is interesting to note that generally the distances determined in the field are longer than those found by photogrammetry.

TABLE 1.

Course number	Length determined in the field, ft	Length determined by photogrammetry, ft	Difference, ft
1.	3234.00	3234.95	0.95
2.	1654.53	1654.28	—0.25
3.	1838.55	1838.67	0.12
4.	5375.08	5375.13	0.05
5.	4482.85	4482.80	—0.05
6.	4093.45	4095.33	1.88
7.	3298.82	3295.61	—3.21
8.	876.72	872.38	—4.34
9.	676.63	677.41	0.78
10.	1343.92	1342.47	—1.45
11.	4116.35	4114.39	—1.96
12.	2362.66	2363.02	0.36
13.	1325.94	1324.39	—1.55
14.	2928.97	2932.15	3.18
15.	1473.88	1473.88	0.00
16.	1264.50	1264.41	—0.09
17.	5632.15	5632.02	—0.13

Major Advantages of Photogrammetry

One of the major advantages of a photogrammetric survey is that the location of each point in the survey can be established independently of the adjacent points. This eliminates the accumulation of errors and the risk of compensating errors inherent in a traverse. Also, the independence of the points permitted the surveyor to work on any portion of the survey without completing all work to that point.

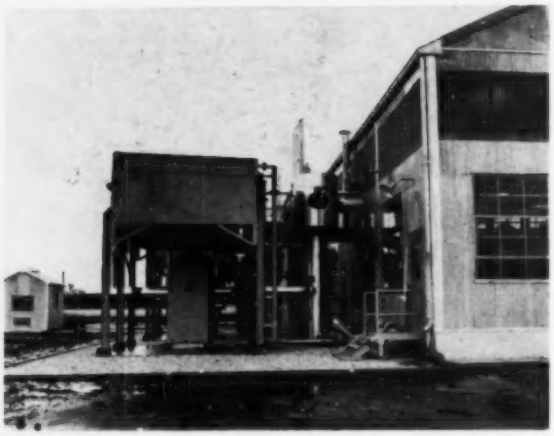
Another feature of a survey of this type is that it can be done with a minimum amount of activity in the field. This can be a decided advantage to those who will follow negotiating rights-of-way.

Relating a survey to the state coordinate system is highly desirable. It eliminates the problems associated with tying the survey to a series of unrelated or inaccurately related surveys of record. Having coordinate values on all points makes the problem of resetting lost points relatively simple. This is true of not only angle points in the pipeline route but monuments on points of record used in the legal description.

This experience with photogrammetry indicates that it is an entirely satisfactory method for surveying a pipeline route. Without exception, the points checked in the as-built survey demonstrate that the accuracy was within the limits required. Work was 95 percent completed 16 weeks after the survey was started. This was estimated to be 40 percent of the time that would have been needed by ground crews. The cost was estimated at 55 percent of the cost for a conventional ground survey.

In view of these results, Pacific Lighting Gas Supply Company would not hesitate to make another survey by photogrammetry. Although photogrammetry was well suited to this survey, it should not be assumed that it is the answer to all survey problems. However, where the survey length is sufficient to justify the cost of the aerial photography or the terrain is such that conventional crews would have difficulty, or where unusual speed is required, this method of survey merits serious consideration. ★ ★ ★

Three vapor phase coolers at Cabeza Creek station in which cooling fans are powered by a steam-driven turbine, the steam being generated by previously wasted heat from the compressor engines.



Position of cooling units with respect to the compressor building is shown here. Turbine is directly below the cooling fan.

Waste Heat Harnessed to Cool Compressor Units

Vapor phase cooling at Cabeza Creek station of United Gas utilizes a by-product and increases operating efficiency

WHEN UNITED GAS PIPE LINE COMPANY'S new Cabeza Creek compressor station near Runge, Texas, in the San Antonio district went on line, it did so with something new — even revolutionary — in cooling systems.

The three-unit station, totaling 2640-hp, was installed to provide compression needed to deliver gas through Cabeza Creek gasoline plant and into the district transmission system. Each of its 880-hp compressor units is equipped with a cooler selected for installation after exhaustive tests, refinements, and modifications of an experimental cooling unit at Agua Dulce compressor station.

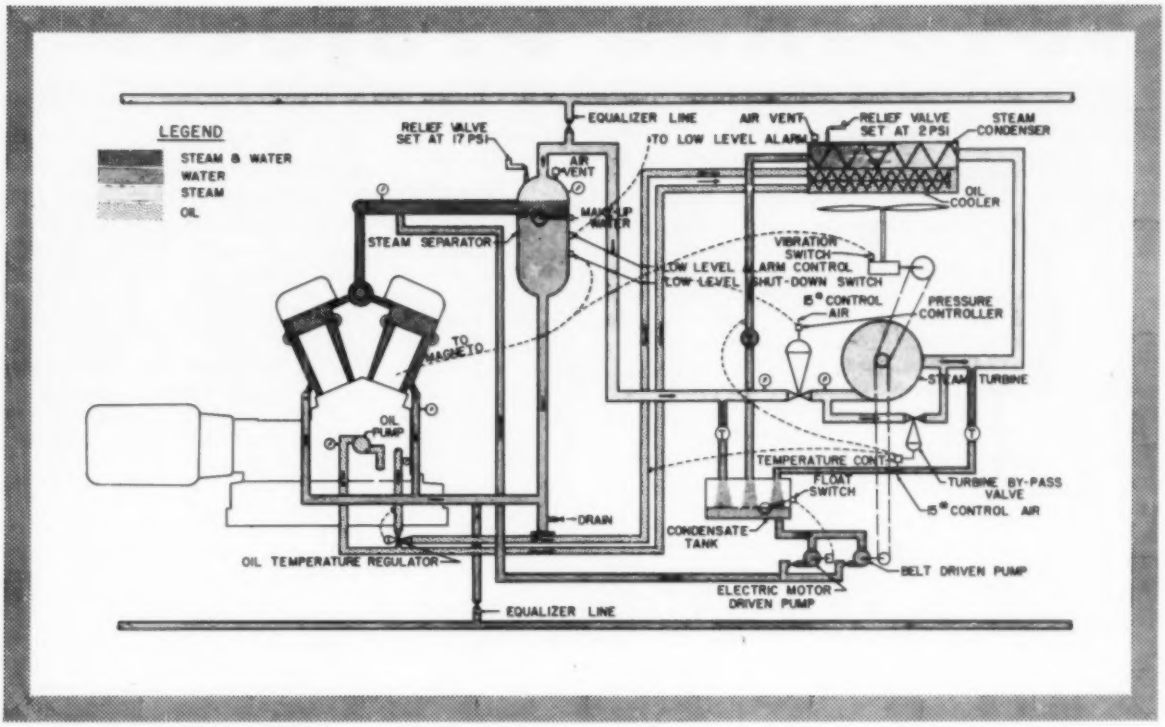
Although it may seem as fantastic as proving that black is white, heat from the running engines is by ingenuous devices adapted to produce the very cooling agent that presents their becoming overheated; but, simply stated, the new coolers merely utilize formerly wasted heat in the generation of steam, which in turn drives a turbine to produce power for the cooling fan.

At Agua Dulce, five 880-hp engines are cooled by the vapor phase* thermal circulation system in which the engine jacket cooling is with water, part of which is allowed to generate steam at atmospheric pressure. Formerly a hydraulic drive system with power take-off from the compressor engine main shafts was employed to drive the cooling fans on all five of these; but in 1956, one of the engines was adapted to generate steam at a high enough pressure to operate a low pressure turbine, which in turn drives the cooling tower fan.

Satisfactory results there, together with a comprehensive study by UGPL's engineering department were determining factors in the decision to fully equip the Cabeza Creek station with the new cooling system.

*"Vapor phase" simply means that jacket water may be in the form of water and steam as compared to older system in which water or other coolant is always liquid, and steam is not allowed to generate.

Purposes for installing vapor phase at Agua Dulce were to achieve general improvement in engine performance—particularly the quality of combustion — to reduce the rate of cylinder and ring wear, and to obtain better results with engine lubrication. To date it has been observed that the engines are cleaner, lubricating oil life has been increased, the crankcases are very clean, and the overall performance is most satisfactory. Steam generation for turbine drive and simplification of the water and oil pumping systems reduce first costs while increasing the compressor engine power output in direct proportion to the reduction of power required for pump and fan operation. Additionally, in the event of any future possible need to burn sour gas in the engines, trouble with acidity will not occur because the cooling temperature with vapor phase is constantly higher than the dew point, and acid fumes therefore remain in the form of inert gas until exhausted.



Vapor Phase Flow Diagram — Note that water and steam from the engine power cylinders flow through a header to the steam separator where the steam is taken off the top to the steam turbine, the turbine exhaust flowing to the steam condenser. The condensate is returned from the condensate tank by pumps to the water and steam header from the power cylinders. The water from the separator returns to the power cylinder jackets by gravity.

In the vapor phase system, instead of pumping the jacket water through a heat exchanger and controlling the outlet temperature as in other systems, the coolant is raised to the boiling point and flows by thermal circulation into the vapor phase unit, which is a cylindrical steam separator with an outlet pipe at the bottom connected to the lower jacket manifold on the engine. The result is rapid circulation with low temperature rise, uniform cooling of the jackets, and automatic temperature control.

Steam in the separator rises to a fan-cooled condenser from which the condensate is returned by gravity to the engine cooling system. Meanwhile, the water in the lower part of the steam separator, having cooled slightly, brings about a specific gravity differential between the down-flow and the water and steam in the jackets, causing continuous circulation up to the steam separator. One part of the cooler acts as a steam condenser, as explained above, and another section cools water, which in turn is circulated through the lube oil cooler by an engine-driven pump. The vapor phase units are tied together by equalizing lines, thus maintaining heat in the jackets of idle engines.

To convert to turbine drive at Agua Dulce, a 6-in. pipe was run from the top of the steam separator to the turbine installed below the finned cooler with a pressure controller in the 6-in. line to assure proper build up of steam pressure ahead of the turbine, thus preventing entry of initial condensate or water. Speed of the turbine is controlled by means of a bypass valve. (See diagram.)

To supply steam for the turbine it was necessary to raise the cooling temperature, which varies according to engine load and ambient temperature. In actual practice the minimum pressure at which the turbine is set to run is 5 psi; and since steam pressure of 15 psig can be obtained at 100 percent load, the system will supply ample cooling at all loads.

In addition to the V-belt driving the cooling fan, the steam turbine drives a small rotary pump, which returns all condensate to the engine cooling system. The electric motor-driven pump shown in the diagram is necessary only when the unit is being put into service and the steam turbine is not operating. Cold lines act to condense steam into liquid, which must be removed prior to operation of the belt-driven condensate pump.

As might well be expected, the experimental unit at Agua Dulce since its installation in 1956 has been subjected to every possible test, incorporating a wide variation and combination of operating conditions, and the mass of compiled data have resulted in numerous improvements that went into installation of the three units at Cabeza Creek.

The more than two score compressor station plants in UGPL's extensive transmission system, totaling almost 168,000 hp, date back to early installation of huge horizontal tandem engines and compressors, which are still in use and performing as well as they did when new.

Over the years, progressive improvements in compressor station facilities have been made, each one of prime interest at the time of installation. Now another step has been taken in the interest of higher efficiency . . . this time—as is often the case—by harnessing a waste or by-product to do a job better than it was done before.

Acknowledgment

Because of the newness and importance of vapor phase cooling, this article, which originally appeared in *United Gas Log*, is reproduced with permission of that publication and United Gas Pipe Line Company. ★ ★

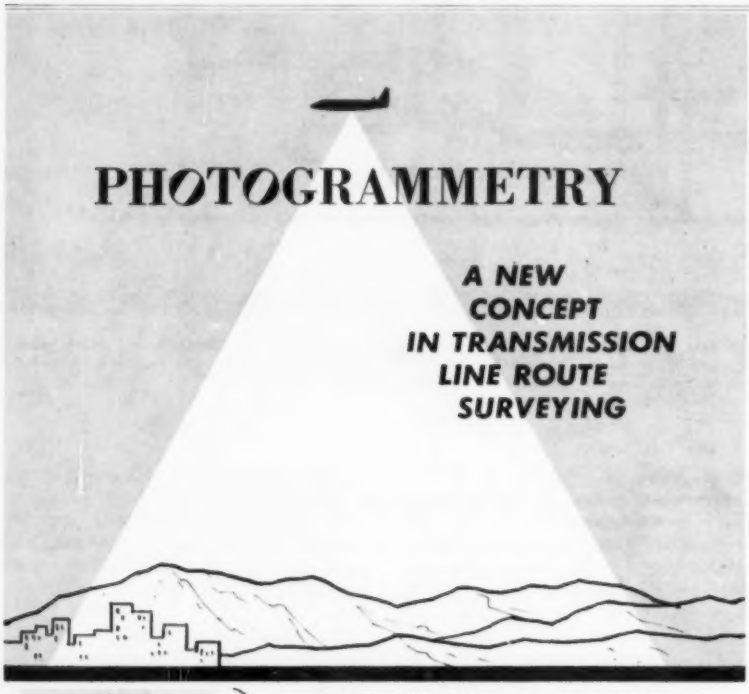
Pipeline Projects

Examiner Approves Proposed $169.3 Million Construction

Tennessee Gas Transmission Company's proposal to construct pipeline facilities costing $169,300,000 has received the approval of a Federal Power Commission examiner. Approval is subject to review by the full commission.

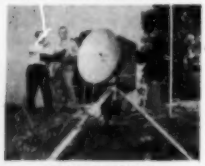
Tennessee Gas will build 1072 miles of pipelines and install 104,250 hp in compressor capacity in Arkansas, Kentucky, Louisiana, Mississippi, New York, Ohio, Pennsylvania, Tennessee, and West Virginia.

It is pointed out that this proposal is not related to the application by Midwestern Gas Transmission Company, Tennessee Gas subsidiary, to build a 2067-mile line to bring Canadian gas into the Midwest. Tennessee said the proposed pipeline will serve only existing customers and not operate in the Midwest.



AERIAL CAMERA

STEREOPLANIGRAPH C-8


GROUND CREWS

Pacific Air Industries, in cooperation with Aerial Control, Inc., have pioneered the application of photogrammetry to the surveying of transmission line routes over all kinds of terrain. Special techniques, together with close team work between ground and air crews, cuts usual surveying costs by as much as 50%.

COMBINED, THIS TEAM OFFERS A NEW SURVEYING TECHNIQUE FOR TRANSMISSION LINE ROUTES.

The working time involved is approximately 40% of the usual time needed by ground crews alone, and includes complete legal right-of-way maps.

PACIFIC AIR INDUSTRIES
725 E. Third Street,
Long Beach, California

AERIAL CONTROL, INC.
21318 Dumetz Road,
Woodland Hills, California

Two Pipelines File With Power Commission

Applications by United Fuel Gas Company and Algonquin Gas Transmission Company, seeking authority for the construction and operation of natural gas facilities, together costing an estimated $3,346,700, have been accepted for filing, the Federal Power Commission announces. The two proposals are not related.

United Fuel (G-12,295) proposes to activate an additional underground storage pool in the Big Sandy district, Kanawha County, West Virginia; to construct about 3.3 miles of 16-in. line from its Coco compressor station to the new storage area, and about 7.3 miles of storage field pipeline and measuring facilities. United Fuel also proposes to abandon approximately five miles of production line within the proposed storage area. Estimated cost of the proposed facilities is about $1,571,700.

Algonquin (G-14,876) proposes to construct a 4000-hp compressor station at Cromwell, Connecticut, at an estimated cost of about $1,775,000. The company said the additional compressor facilities would provide an increased margin of safety between its system requirements and system capacity.

Work Begins on New York State Natural Line

Work began the first week in June on a 13-mile pipeline between New York State Natural Gas Corporation's Harrison storage pool and its State Line compressor station. The company scheduled the project after receiving temporary authorization from the Federal Power Commission.

Both Harrison and State Line facilities are in Potter County, Pennsylvania, below the New York border.

The new 20-in. line will replace an existing 12-in. line and will cost about $934,000, a company spokesman said.

The larger line is to serve increased demand for natural gas by the company's customer firms in New York state.

New York Natural is spending approximately $8.7 million during 1958 for pipelines of all kinds. Of this amount, about $4.6 million will be in for the laying of 60 miles of transmission lines of all sizes throughout its system. The Harrison-State Line project is included in the latter figure. The company now has 1745 miles of pipelines in Pennsylvania and New York.

Two Budget-Type Proposals Granted

The Federal Power Commission has issued orders authorizing the construction of natural gas facilities, estimated to cost about $4,000,000, under budget-type proposals by Trunkline Gas Company and Texas Gas Transmission Corporation. The proposals are not related.

Trunkline (G-14,365) will construct such facilities as are necessary to enable it to purchase from time to time natural gas as it becomes available in the general area of its system during 1958. The cost of any single project will not exceed $250,000 and the total cost will not exceed $1,000,000.

Texas Gas (G-14,514) will construct the necessary facilities to enable it to take into its pipeline system natural gas it may purchase from independent producers in its system area. Facilities will be constructed from time to time during the next 12 months. Cost of any single project will not exceed $400,000 and total cost will not be in excess of $3,000,000.

Ohio Gas Storage Field Temporarily Authorized

The Federal Power Commission has granted The Ohio Fuel Gas Company temporary authorization to develop a natural gas storage field in Medina County, Ohio. Ohio Fuel proposes to convert the depleted Medina gas producing area into an underground storage field.

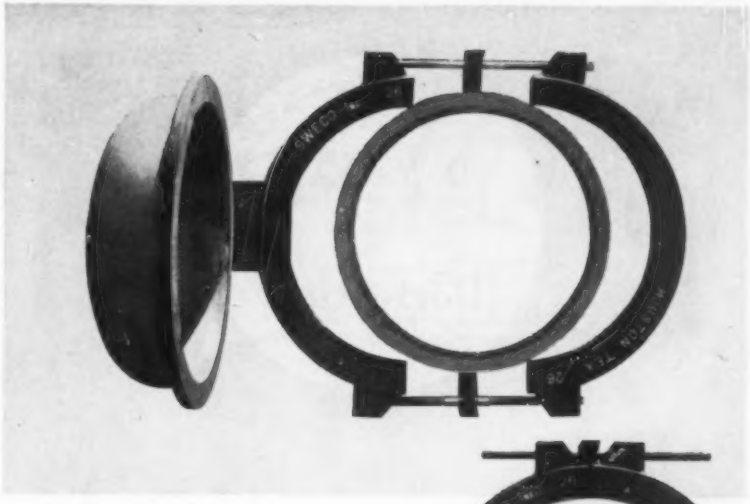
Activation and development of the new storage field, Ohio Fuel's application said, would include the installation of approximately 12.4 miles of 4½ to 20-in. pipeline and a 3300-hp compressor station. About 2.7 miles of small diameter pipeline would be abandoned in the field. Estimated cost for the initial conversion is about $2,171,400. The ultimate cost for full development is estimated at approximately $5,075,500.

Ultimate storage capacity is estimated at 8,500,000,000 cu ft.

Trunkline River Crossing Gets Final Approval

Trunkline Gas Company has been issued an FPC certificate to construct a pipeline crossing of the Red River in Louisiana.

Facilities, estimated to cost $1,750,000, include two 24-in. pipelines, each about 5240 ft long, across the Red River in Rapides Parish, Louisiana. The new crossing is designed to provide greater protection against any possible curtailment of its service, Trunkline said. The FPC recently granted temporary authorization for construction of the facilities.



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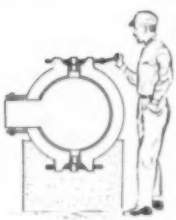
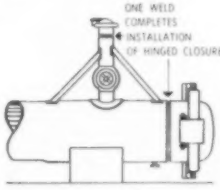
For scraper traps, blowdowns, meter runs, vessels, tanks, strainers, filters, heat exchangers, where blind flanges or manways are required.

EASY TO INSTALL. The Sweco Hinged Closure comes completely assembled. No davits, hoists or stud bolts necessary. Installed with only one weld.



EASY TO OPEN AND CLOSE. One man with any standard wrench can easily open and close a 32" 1000# W.O.G. Sweco Hinged Closure in a few minutes. No threads or lugs to engage or flanges to line up when opening or closing. *Hinge is integral part of every Sweco Closure.*



SAFE. Thoroughly tested. Door of the Sweco Closure cannot be opened without absolute pressure relief. Yoke acts as safety cage until completely spread.

ECONOMICAL TO MAINTAIN. Oil resistant seal of the Sweco Closure is a static "O" ring which does not move and is not rubbed . . . assuring long seal life.

STOCK ITEMS in all pipe sizes 2" through 32", 1000# W.O.G. Larger sizes and bores available.

Call or write today for complete information. Let us show you how we are helping pipeline companies save time, money, and manpower with the all new Sweco Closure.

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Distributed by Southwest Equipment Co., 1803 Prudential Bldg., Houston, JAckson 2-5444 or your local supplier.

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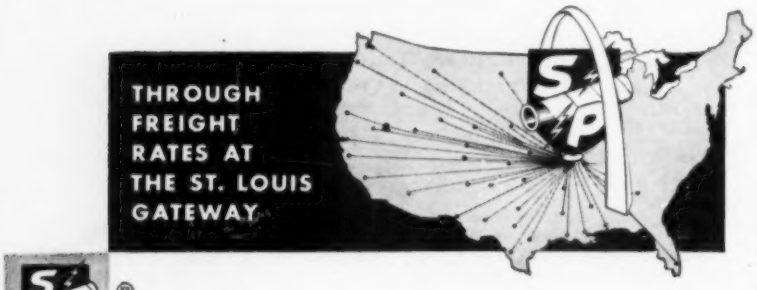
STEEL GRIT CLEANING

The ping of millions of pieces of steel grit bouncing off your pipe at Standard Pipeprotection assures you that your pipe is being cleaned to perfection. Not only is all mill scale and rust removed, but the surface of the pipe is etched with many tiny facets, inclined toward each other at various angles, that provide an ideal surface for bonding the enamel to the pipe.

Steel grit cleaning is far superior to sand blasting or wire brushing. Every piece of pipe is steel grit cleaned at SPI.



standard pipeprotection inc.

3000 SOUTH BRENTWOOD BLVD. • ST. LOUIS 17, MISSOURI

Projects

New Products System for Illinois and Indiana

The Ohio Oil Company and Continental Oil Company have formed the Wabash Pipe Line Company to build and own more than 350 miles of refined petroleum products common carrier pipelines in Illinois and Indiana. Ohio Oil will hold 75 percent of the stock and Continental 25 percent. Ohio Oil will operate the system for Wabash.

One section of the new pipeline, extending 85 miles from Robinson to Champaign, Illinois, is completed. At Champaign this products line will be tied into a 265-mile Wabash line under construction from Wood River, Illinois, to East Chicago, Indiana.

Ultimate capacity of the new 12-in. system will be from 90,000 to 100,000 bbl a day. Outdoor electrtic pump stations are planned at Wood River, Robinson, and Champaign, with others added later as needed. The stations will utilize a power-saving fluid drive pioneered by Ohio Oil.

The section from Robinson to Champaign will carry products from Ohio Oil's refinery at Robinson. At Wood River, the Wabash system will receive, deliveries from the Cherokee Pipe Line system, which is connected to the Continental and Cities Service refineries at Ponca City, Oklahoma, and the D-X Sunray and The Texas Company refineries in the Tulsa area. Wabash can also take products from several large refineries in the Wood River-East St. Louis area.

Wabash plans to have the Wood River-East Chicago line completed so that the entire system will be ready for operation by year's end. Meanwhile, products will be moved from Wood River through the Ohio Oil Company's existing products line to Martinsville and then through the just completed Wabash line extending north to Champaign.

Wabash also will have delivery facilities at Campaign, Illinois, and Griffith, Indiana, in the East Chicago area, and will deliver to a privately owned terminal nearing completion at Campaign and to a large privately owned terminal soon to be constructed at Griffith.

Wabash will make deliveries to water loading facilities for shipment of refined products by canal to Chicago, and by lake-going vessels to other Great Lakes ports. Wabash also can be connected to other products pipelines in the East Chicago area.

Directors of the Wabash Pipe Line Company are: J. H. Rice, K. E. Tappy, and C. A. Jackson, of the Ohio Oil Company; and H. R. Wall; John T. Kelly, and W. L. Kygar of Continental. Officers and their affiliations are: J. H. Rice of Ohio Oil, president; R. M.

Slough of Ohio Oil and W. L. Kygar of Continental, vice presidents; Calvin A. Brown of Ohio Oil, secretary; R. H. Brown of Ohio Oil, John D. Morrow and P. J. Dominic of Continental, assistant secretaries; C. A. Jackson of Ohio Oil, treasurer; S. F. Nash of Ohio Oil and L. C. Peters of Continental, assistant treasurers.

Ohio Fuel Gas Proposes 51 Miles of Pipeline

The Ohio Fuel Gas Company has applied to the Federal Power Commission for authority to construct 51 miles of pipeline on various parts of its transmission system in Ohio.

The application also proposes the abandonment of a total of 39 miles of line, which would be replaced by sections of the proposed new pipe.

Proposed construction is estimated to cost a total of approximately $2,163,000, and the retirement cost is estimated at $91,000. Salvage from the retired sections of line, however, is expected to total about $109,000. The sections of new line would be located in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark, and Wayne counties.

WHEN IT COMES TO SERVICE
COME TO REILLY

Dick Renshaw is well known to all Reilly Enamel users because he heads up Reilly's Hot Enamel Field Service Group.

He is a practical Corrosion Engineer and has an intimate knowledge of the composition of enamel and of the techniques of its manufacture and use. As a result, his capabilities are held in high esteem throughout the industry.

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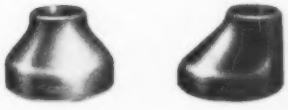
WELDING FITTINGS

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.



SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Complete encirclement saddles.

Fast interested service.
Write for Literature.

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Canadian News Notes

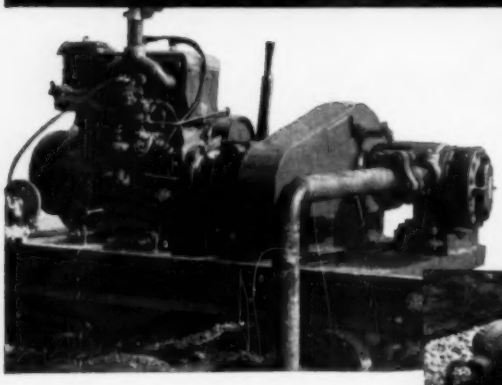
Northern Ontario Lets Contract for Lateral

Construction contract for the 90-mile 10-in. natural gas lateral to Sudbury, in west central Ontario, from the main line of Trans-Canada Pipe Lines Ltd., at North Bay, has been awarded to Mannix, Company, Ltd., of Calgary. Mannix has also been awarded the city distribution contracts for Sudbury and the adjacent town of Copper Cliff, comprising 220,000 and 40,000 ft, respectively, of 2 to 8-in. pipe.

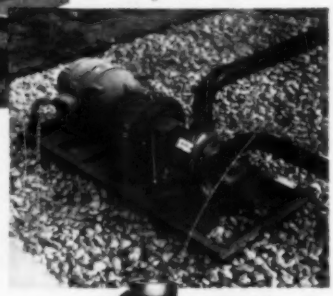
The owner is Northern Ontario Natural Gas Company, Ltd. Work began May 26 on the distribution systems, with an objective completion date of late fall.

The grading and rock ditch on the lateral were scheduled to kick off on June 9, but owing to the large mileage of rock it is not expected that pipe laying will begin until August. The right-of-way runs largely through Precambrian granite, the hardest rock known on the face of the earth.

How They Rely on These ROPERS!



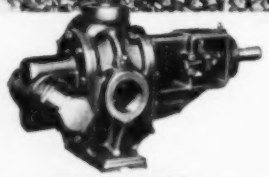
SERIES H PUMP
To 600 PSI—10 to 75 GPM
Packed box or mechanical seal. Widely used for gathering lines.



SERIES H AND SERIES 3600 PUMPS SPECIFIED FOR PIPE LINE HOOK-UPS

Regardless of the power supply used, ROPER PUMPS offer dependable service on continuous or intermittent pumping. These pumps give the advantage of design simplicity . . . two equal size, precision-mated gears run in axial hydraulic balance for positive displacement and assurance of smooth, non-pulsating flow in either direction of rotation. One of the outstanding features of the ROPER design is easy accessibility to the working parts. Neither piping nor mountings are disturbed whether for making a simple inspection or a major repair.

Specify ROPERS for close-in or remote installations. They will provide the *dependable pumping* you must have.



SERIES 3600 PUMP
To 100 PSI—20 to 300 GPM
Packed box or mechanical seal. For gathering lines or circulating and transfer.

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ROPER
ROTARY PUMPS

Pentzien to Make Three Major River Crossings

Pentzien Canada, Ltd., has been awarded the contracts for three major river crossings on the 30-in. northwestern Ontario natural gas pipeline of Northern Ontario Pipe Line Crown Corporation. The company is a subsidiary of Pentzien, Inc., of Omaha, Nebraska. It had the contract for the crossing of the Lake of Two Mountains near Montreal at the eastern end of the Trans-Canadian pipeline last year.

First crossing involved is the Nipigon River, in solid granite rock, between spreads V and W, at MP 374.3 on the Crown line, immediately south of the town of Nipigon. The second is the Kenogami River, near the eastern end of spread X, at MP 487, just west of the town of Longlac. The third is the Missinaibi River, halfway along spread Z, at MP 632, which is approximately 45 miles west of the end of the Crown line at Kapuskasing. Both these crossings are in wide swampy channels with difficult approaches, but the water in the channels is relately shallow.

Second Crude Line From Swan Hills is Authorized

A second construction permit for a crude oil pipeline out of the Swan Hills oil pool in north central Alberta has been issued by the minister of mines and minerals. The successful applicant is Peace River Oil Pipe Line Company, Ltd., which already operates the 12-in. and 16-in. line out of the Sturgeon Lake area fields.

The line is 75 miles long, running southwest from the pool to join its own main line at Iosegun Junction. It would pick up crude from the Virginia Hills and Windfall pools on the way.

Four Short Lines Finish Alberta Gas 1958 Work

The Alberta Gas Trunk Line Company, Ltd., has awarded the remaining contracts for its 1958 laterals to Preston, Clarke, Ltd., of Edmonton. Four short lines are included: 11 miles of 6-in. for Sibbald gas field, 5 miles of 6-in. for the Atlee-Buffalo field, 1¼ miles of 8-in. for Princess, and 1½ miles of 8-in. for Steveville.

Condensate Line Scheduled For Late August Completion

A small but difficult job of laying condensate gathering lines in the big Pincher Creek gas field of southwestern Alberta has been awarded to Mannix Company, Ltd., of Calgary by The British American Oil Company, Ltd. The contract involves 20 miles of 2 to 14-in. lines for the wet gas condensate, which will be produced with the gas from the Pincher Creek field when it goes on Trans-Canada supply next fall.

PIPELINE PERSONALS

▸ Four Texas Eastern Transmission Corporation engineers have been promoted in the engineering department: **Conrad W. Marvin** has been named assistant chief engineer; **Jay J. Ball,** supervising engineer; **George H. Ewing,** assistant supervising engineer, and **Gordon L. Jennings,** supervisor of engineering plans and research.

C. W. Marvin

J. J. Ball

Marvin was formerly supervising engineer; Ball was assistant supervising engineer; Ewing was supervisor of plans and research, and Jennings was assistant supervisor of plans and research.

G. H. Ewing

G. L. Jennings

▸ **Wilber H. Mack** has been elected executive vice president of the American Louisiana Pipe Line Company and the Michigan Wisconsin Pipe Line Company. Mack will continue as director and general attorney for both pipeline companies. He also is secretary of American Louisiana, director and general attorney of the affiliated American Natural Gas Service Company as well as director, vice president and secretary of American Natural Gas Production Company.

W. H. Mack

J. J. Trebilcott

▸ **James J. Trebilcott** has been promoted to manager of operations and **Charles J. McInerney** to secretary of the Michigan Wisconsin Pipe Line Company. Trebilcott joined Michigan Wisconsin in 1948, later becoming administrative assistant to the vice president in charge of operations. He was appointed assistant manager of operations last February. McInerney became legal assistant to the secretary of Michigan Consolidated Gas Company, an affiliate of Michigan Wisconsin Pipe Line, in November 1945. He was named assistant secretary in June 1950. He also is an attorney for the firm and assistant secretary of the affiliated American Louisiana Pipe Line Company.

H. C. Price Jr.

▸ **Harold C. Price** Jr., vice president of H. C. Price Company, will assume the duties and responsibilities now performed by **John M. Thomas,** vice president, who has retired. Thomas will maintain association with the company as a member of the board of directors of the company and of H. C. Price of Canada, Ltd. He will also be retained as pipeline consultant.

▸ **Harry Ronan** has been named manager, two-way radio sales, a new position, for the 15-state eastern area reporting to **Lowell White,** vice president and eastern area manager of Motorola Communications & Electronics, Inc., a wholly owned subsidiary of Motorola, Inc. Replacing Ronan as New England regional sales manager is **Ed Vogel,** who has been a zone manager there.

Named to two new special sales posts are **Pat Kelly** and **Bob Swift,** who had been sales engineering administrators in the eastern and midwest areas respectively. Kelly is now account executive manager, eastern area, and Swift is sales manager, special markets, in the midwest.

▸ **Fred Jones,** formerly superintendent of communications and electrical engineering for Platte Pipe Line Company, Kansas City, Missouri, has been promoted to the post of superintendent of engineering and communications. In his new duties he is responsible for mechanical, hydraulic, and civil engineering as well as for communications and electrical engineering.

▸ **Peter R. Braginton** has joined the Al N. Ohlfest Company as sales engineer for systems planning in the utilization of tone carrier terminal equipment manufactured by Radio Frequency Laboratories, Boonton, New Jersey. The company's operations cover the states of Texas, Oklahoma, Arkansas, and Louisiana, with headquarters in Dallas, Texas.

Braginton formerly was associated with Collins Radio Company (Texas Division) in various engineering supervisory capacities.

He is a graduate in electrical engineering from the U. S. Naval Academy (1944) and Massachusetts Institute of Technology (1948).

▸ **Andrew J. Shoup** has been elected vice president and chief engineer of Texas Eastern Transmission Corporation. He takes over the post recently vacated when **Baxter D. Goodrich** was promoted to senior vice president. Shoup was formerly assistant chief engineer.

▸ **Merlyn M. McInturf,** chief engineer at the Ohio Fuel Gas Company's Weaver compressor station for the past five years, has been named Southern compressor division superintendent for Ohio Fuel. His offices will be at Ohio Fuel's Crawford compressor station near Sugar Grove. He succeeds **John Adams,** who has retired.

▸ **Lloyd C. King** has been advanced to assistant to the general superintendent of The Peoples Natural Gas Company. He was assistant superintendent of production and transmission at the time of his promotion.

▸ **E. J. Jandacek** has been made chief engineer for Texas Gas Transmission Corporation. He has been assistant chief engineer for Texas Gas since 1949.

▸ **S. R. "Steve" Sawyer,** formerly of El Paso Natural Gas Company, has been appointed chief engineer of Trans-Canada Pipe Lines Ltd., with headquarters in Toronto.

▸ **W. A. Campbell,** manager of government relations, and **W. E. Locher,** manager of operations, have been elected vice presidents of Trans-Arabian Pipe Line Company, with headquarters in Beirut, Lebanon.

WITH THE PIPELINE CONTRACTORS

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela.* Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta.** Has 57 miles of 30-in. line for *Trans-Canada Pipe Lines.* Has contract for 80 miles of gathering lines for *Westcoast Transmission Company's* natural gas grid system in the Peace River region; plans call for laying some 20-in. as an extension to the main line and also smaller diameter lines down to 6-in. for the Blueberry field.

● **Oklahoma Pipe Line Constructors, P. O. Box 13227, Dallas 20, Texas.** Has 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela; this is the company's first Venezuelan venture since 1944. Has 50 miles of 22-in. loops for *Portland Pipe Line Corporation* and *Montreal Pipe Line Company;* 39 miles in U. S. and 11 miles in Canada. Has 90 miles of 30-in. (known as Spread 14) for *Trans-Canada Pipe Lines, Ltd.,* from Toronto, Ontario, northward.

● **O. R. Burden Construction Corporation, Box 5216, Tulsa, Oklahoma.** Has 90 miles of 16-in. for *Humble Pipe Line Company* from Humble's Comyn station in Comanche County to its Hawley station in Jones County, Texas. Also has 76 miles of 20-in. for *Service Pipe Line Company* between Casper and Fort Laramie, Wyoming. Has 32.8 miles of 16-in. line to lay for *Panhandle Eastern Pipe Line Company* near Muncie, Indiana.

● **Vaughn and Taylor Construction Company, Inc., P. O. Box 3266, Odessa, Texas.** Has contract for 48 miles of 8, 6, and 4-in. line between Kermit and Goldsmith, Texas, for *El Paso Natural Gas Company.*

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has 36,000 ft of 24 and 12-in. sea-loading line for *American Independent Oil Company* at Kuwait into the Persian Gulf. Has trenching contract with *Commonwealth Oil Company* for 10.6 miles of 12-in. offshore line in West Delta block in Gulf of Mexico.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **Construction Service Company, P. O. Box 311, Bound Brook, New Jersey.** Has 18 miles of 12-in between Trinity and Gala, Virginia, for *Roanoke Gas Company.*

the new CRC *ELECTRO-HYDRAULIC INSIDE*

LINE-UP CLAMP

IS POSITIVE POWER EXPANDING

The new C-R-C Electro-Hydraulic Line-Up Clamp with high pressure line-up capacity, speeds lining-up operations quickly and safely.
The clamp has hydraulic pressures sufficient to expand large diameter pipe. A four-section expansion shoe eliminates high-lows in the pipe. No hand cranking or hammering necessary. The clamp derives its power from the stringer bead welding machine . . . no other power source needed.
Sizes range from 18" to 36" pipe size . . . rental basis only.

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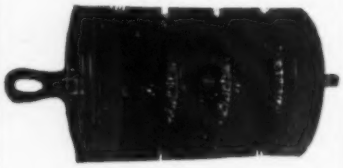

for BETTER cleaning of
CRUDE LINES
PRODUCT LINES
NATURAL GAS LINES

FOR DETAILS WRITE

Pipeline Cleaners Co.
Fort Madison, Iowa

Contractors

● **F. E. Shaw, Ltd., 530 S. Vidal Street, Sarnia, Ontario.** Has 40 miles of 6 to 10-in. line for *Dominion Natural Gas Company, Ltd.*, in the Brantford, St. Catharines, and St. Thomas districts. Has 67 miles of 6 to 20-in. transmission lines for *Union Gas Company*, Chatam, Ontario, to Dawn, London, St. Marys, Stratford, Kitchener and Guelph.

● **Macco Corporation, 14409 Paramount Blvd., Paramount, California.** Has 20 crews installing and replacing gas pipelines in Southern California area for *Southern California Gas Company* and *Southern Counties Gas Company*.

● **Piggott Construction, Ltd, Calgary, Canada.** For *Interprovincial Pipe Line Company*, 82 miles of 24-in. loops in Alberta and Saskatchewan. For *Alberta Gas Trunk Line Company*, 145 miles of 24-in. from Pincher Creek field to Princess Junction, Alberta.

● **Mannix Company Limited, 737 Eighth Avenue West, Calgary, Alberta.** Has 90 miles of 10-in. between Sudbury and North Bay, Ontario for *Northern Ontario Natural Gas Company, Ltd.* Has 220,000 ft of gas distribution lines in Sudbury for *Northern Ontario;* also has 40,000 ft of gas distribution lines in Copper Cliff, Ontario for same company. Also has 20 miles of 2 to 14-in. for *British American Oil Company, Ltd.;* this contract is for construction of a wet-gas condensate gathering system in the Pincher Creek, Alberta, area, and includes considerable quantity of high pressure stress-relieved pipeline.

THREAD LEAK REPAIR —QUICK, FINAL!

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure — without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

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SOUTH BEND 21, INDIANA, U. S. A.

Laugh with Barney

Mr. Chan owned a warehouse full of teakwood which was repeatedly burglarized. One day he made a tour of his warehouse looking for clues. He found a broken window and tracks, similar to that of a small boy. That night Mr. Chan stayed in the warehouse to catch the thief stealing his teakwood. At midnight a bear climbed in the window and picked up a load of teakwood and started off. The Chinaman jumped out and cried: "Stop, boyfoot bear with teaks of Chan!"

One snowy morning prior to his father's departure: "Mommy, can Freddie and I go out and listen to Daddy put on the tire chains?"

Lion tamer: "My dad was a lion tamer, too."

Reporter: "Did you ever put your head in a lion's mouth?"

Lion tamer: "Only once. To look for Dad."

Oilman Bill would like to drown his troubles . . . but he can't get his wife to go swimming.

Keep smiling. It makes everyone wonder what you've been up to.

"I'm going to fire that chauffeur," shouted Mr. Brown. "This is the third time this week he nearly killed me."

"Now, now, dear," soothed his wife. "Give the poor man another chance."

"Look out!" shouted the motorist to the pedestrian he had just knocked down.

"Why?" despaired the victim. "Don't tell me you're coming back?"

"I tell you I won't have this room," protested the old lady to the bellboy. "I ain't going to pay good money for a room no bigger than a closet with a measly folding bed in it. Jest because I'm from the country . . ."

"Get in, ma'am, get in. This is the elevator."

The reason young people sow wild oats is because they've gotta be sowed while you've got 'em.

Sign at a Louisiana railroad crossing: The average time it takes a train to cross this road is 14 seconds — whether your car is on it or not.

A fellow who had had "just two" drinks with the boys was driving the wrong way on a one way street. Of course a cop stopped him. "Where do you think you're going?" he growled.

"I dunno," answered the fellow, "but I must be late. Everybody's comin' back."

A hobby is something you get goofy about to keep from going nuts about things in general.

Said one crazy twin to the other: If it weren't for me you'd have two heads.

Heard any good stories lately? Send them to Barney, Box 1589, Dallas 21, Texas.

Panting and perspiring, two Irishmen on a tandem bicycle, at last got to the top of a steep hill.

"That was a stiff climb, Pat," said Mike.

"Sure and it was Pat, and if I hadn't kept the brake on we would have gone backward."

A fellow just called by his draft board happened to remember a friend who had been rejected because he wore a truss. So he hastily purchased one and reported to the board. After the examination he noticed the official had put N.E. after his name.

"What's the N.E. for?" he asked.

"Near East," was the reply. "Anybody who can wear a truss upside down can ride a camel."

The little old lady was taking her first ocean voyage. A huge whale was sighted and as the passengers crowded around the rails, sure enough, the whale spouted terrifically. She gasped. "It looks to me like it could at least stop laying on its back and showing off like that she fumed as she hurried to her stateroom.

At Sunday School, little Bobby was highly impressed by the story of Eve's creation from one of Adam's ribs. Later in the day Bobby felt a pain in his side. "Oh, mother," he gasped, "I think I'm going to have a wife!"

Betcha didn't know a crowded elevator smells different to a midget.

"Hello, George — why the happy expression?"

"I just gotta a cute dog for my wife."

"Gee, wish I could make a good trade like that!"

Luke: "Gosh — but I'd like to make your dreams come true!"

Lulu: "I'll slap your face if you try it!"

A recent bridegroom wrote to one of his creditors: "Sorry this bill has gone unpaid so long. I've been on my honeymoon and will pay you as soon as I get back on my feet."

EXPENSE ACCOUNT WITH A STORY

Date	*Item*	*Amount*
4-1	Add for stenographer	$ 2.19
4-5	Flowers for Stenographer	4.50
4-9	Wkly salary - stenographer	50.00
4-10	Hoisery for stenographer	1.75
4-11	Candy for wife	.80
4-12	Lunch with stenographer	5.25
4-13	Wkly salary - stenographer	60.00
4-19	Movies - self and wife	1.20
4-20	Theatre tickets - self&steno	9.60
4-21	Coca-Cola for wife	.10
5-2	Champagne, dinner - steno	32.75
5-3	Dorothy's salary	75.00
5-6	Champagne, dinner - Dotty	41.00
6-27	Doctor	450.00
6-28	Fur coat for wife	975.00
6-29	Ad for male stenographer	2.19

Don't Start Any
VAST PROJECTS
With
HALF VAST IDEAS!

Contractors

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has contract for 51 miles of 10-in. and 6 miles of 6-in. for *Buckeye Pipe Line Company*. The 10-in. line is between Utica and Syracuse, New York; the 6-in. is near Auburn, New York.

● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has contract on Spread Y, containing 91.3 miles of 30-in. gas line from Longlac to MP 584.8 at the east bank of the Shekak River for *Northern Ontario Pipe Line Crown Corporation*.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has contract for 70.9 miles, 30-in., *Northern Ontario Pipe Line Crown Corp.*, between Beardmore to Longlac, Ontario. Has undetermined amount of gathering system for *Producers Pipeline Ltd.* in the Estavan, Saskatchewan, area. Has contract to lay city distribution system in Cooksville, Ontario, for *Consumer Gas Company*. Has city distribution system in Guelph, Ontario, for *Union Gas of Canada*. Has contract with *Trans-Canada Pipe Lines Ltd.* for 80 miles of 30-in. from Iroquois Falls to Kirkland Lake, Ontario.

● **Latex Construction Company of Georgia, Box 12128, Atlanta 5, Georgia.** Has 58 miles of 8-in. for *South Carolina Natural Gas Company* from a point near Aiken to Hampton, South Carolina. Has contract for 14 miles of 18-in. and 16 miles of 12-in. loop lines near Petersburg and Richmond, Virginia for *Commonwealth Natural Gas Company*. Has seven miles of 6-in. for *Standard Southern Corporation* between State docks and Hunter AFB in Savannah, Georgia. Also has contract for 12 miles of 4-in. on a recondition job for *Plantation Pipe Line Company*.

● **Arey Pipe and Construction Company, Inc., Box 1501, Pampa, Texas.** Has 105 miles of 6-in. for *West Emerald Pipeline Corporation* between Amarillo, Texas and Tucumcari, New Mexico.

● **Western Pipe Line, Inc., 1011 San Jacinto, Austin 66, Texas.** Has 94 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Hawk Lake and Hyndeman, Ontario.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has 45 miles of 12-in. and smaller gas line for *Southern Natural Gas Company* southeast of New Orleans, Louisiana; this is a lay barge and quarter-boat operation. Has 216 miles of 30-in. gas line loops for *Gulf Interstate Gas Company* in the states of Louisiana, Mississippi, and Tennessee.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area.

● **Lone Star Pipe Line Constructors, Inc., 10301 Shady Trail, Dallas, Texas.** Has 143 miles of 20-in. crude line between Teague and Houston, Texas, for *Sinclair Pipe Line Company*.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 100 miles of 18-in. for *Alberta Gas Trunk Line Company, Ltd.*, from Burstall at the Alberta border to Provost, Alberta. Also has 22 miles of gas gathering line in the Provost field for *Provo Gas Producers, Ltd.*, consisting of constructing gathering system and wellhead tie-ins—3 to 12-in. pipe; this gas to be fed to Alberta Gas Trunk Lines. Has contract with *Saskatchewan Power Corporation* for 124 miles of 10-in. line from Steelman to Regina and 38 miles of 12-in. from main line's present terminus at Moose Jaw extending to Regina.

● **Engelking and James, Ltd., Edmonton, Alberta.** Has 88 miles of 14-in., 3.5 miles of 16-in. and a total of 23 miles of various other lines for *Saskatchewan Power Corporation* from and in Success and Hatton gas fields in Saskatchewan.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Morrison-Shivers, Ltd., Box 1076, Austin, Texas.** Has 48 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Nipigon and Beardmore. Also has 62 miles of 30-in. for *Trans-Canada Pipe Lines* at North Bay, Ontario.

● **Harvey B. White Limited, Box 158, Windsor, Ontario.** Has undetermined amount of 4 to 8-in. distribution lines for *Consumers Gas Company* in cities of Pickering and Whitby, Ontario. Has undetermined amount of 2 to 6-in. distribution lines throughout Windsor, Ontario for *Union Gas Company*.

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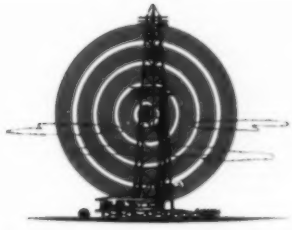

JULY 1958

Drilling Rig Locator

An exclusive summary of oil field contract drilling rigs — rotary and cable tool — in the U. S. and Canada, including a Special Offshore Section and some foreign contract rigs. Plus the all NEW SPECIAL SECTION OF CONTRACT WELL SERVICING EQUIPMENT, U. S. and Canadian.

The Petroleum Engineer's July 1958

DRILLING RIG LOCATOR

Including U. S. and Canadian Well Servicing Units

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DRILLING RIG LOCATOR

A summary of U. S. and Canadian Drilling Contractors, their names and addresses, location and specifications of both cable tool and rotary rigs, some rigs in foreign service, U. S. offshore rigs, and the new well servicing contractors RIG LOCATOR.

Nine issues and 2½ years ago, the first exclusive directory of contract drilling rigs made its first appearance. That was October 1955. Each edition was an improvement over the old . . . something new and different had been added . . . to make it of greater value to both the producer and the contractor. And . . . now . . . another big, new feature has been added.

All New Well Servicing Rig Directory

Contract equipment availability would not be complete without including the thousands of rigs used daily in all manner of well servicing. It's a formidable task to get pertinent specifications on all the types of rigs used in the U.S. and Canada for well work. It took months of preparation, planning and execution. But . . . here, for the first time . . . is our initial effort to present to industry the contractors' names, addresses, pertinent equipment specifications and location of three basic types of well servicing rigs: (1) Pulling or well servicing units, (2) cable tool servicing rig, and (3) rotary workover rigs. We hope you find it of value . . . and we welcome your comments, criticisms and suggestions. Appreciation is extended to officers and members of the Association of Oilwell Servicing Contractors for help freely given on the new *Well Servicing Contract Rig Section*.

Use of abbreviations. In a directory of this type where certain specifications are included, it was necessary in the conservation of space to make some abbreviations. Under the column of "type power," the following abbreviations apply: Dsl for diesel; gaso for gasoline; stm for steam; btne for butane; and dsl elec for diesel electric. In listing drawworks make and model number, it was necessary to abbreviate the manufacturer's name. Some of these abbreviations are well known; others had to be made to fit the available space. Here's the code we used:

Manufacturer's Company Name	Abbreviation
ALCO Products, Inc. (formerly Beaumont Iron Works Div. of American Locomotive Co.)	ALCO-BIW
Allis-Chalmers Manufacturing Co.	Allis Chmrs
American Iron & Machine Works	Amer
Ansaldo	Ansaldo
Beaumont Iron Works (See ALCO Products, Inc., name no longer officially used)	ALCO-BIW
Bethlehem Supply Co.	Beth
Big Four Machine & Supply Co.	Big Four
Border Foundry & Machine	Border
The Brewster Co., Inc.	Brwstr
Bucyrus-Erie Co.	B. Erie
Cardwell Manufacturing Co., Inc.	Crdwll
Clark Bros. Co., Inc.	Clark
Fred E. Cooper, Inc.	Cooper
Continental-Emsco Co.	Emsco
Cummins Engine Co., Inc.	Cummins
George E. Failing Co.	Failing
Franks Division of Cabot Shops, Inc.	Frnks
General Machine Co.	Gen Mach
Hacker Machine & Supply Co.	Hacker
Hopper Machine Works, Inc.	Hopper
Houston Tool Co.	Hou
Howard-Turner Machine Works	Howard-Turner
Ideco, Inc.	Ideco
Ingersoll-Rand Co.	Ingersoll
Jones, Shelburne & Guffey Co.	JS&G
Joy Manufacturing Co.	Joy
Mayhew Supply Co., Inc.	Mayhew
Lee C. Moore Corp.	L. C. Moore
Lucey Export Corp.	Lucey
Muskogee Iron Works	MIW
The National Supply Co.	Natl
Oil Well Supply Division (U. S. Steel Corp.)	"Oilwell"
Reich Bros.	Reich
Spencer-Harris Machine & Tool Co.	Spencer
Stardrill-Keystone Co.	Star
Texas Iron Works, Inc.	TIW
Unit Rig & Equipment Co.	Unit
Vickers, Inc.	Vickers
Victoria Machine Works	Vic
Wagner-Morehouse, Inc.	Wgnr-Mrhse
Walker-Neer Manufacturing Co., Inc.	Wlkr-Nr
Waldrip Engineering Co.	Wldrp
Well Machinery & Supply Co., Inc.	Ft. Wrth
Wheeling Machine Products Co.	Wheeling
The Wheland Co.	Whlnd
Wichita Tool Supply Co.	Wich
Wichtex Machinery Co., Inc.	Wichtex
Wilson Manufacturing Co., Inc.	Wlsn

U. S. Drilling Contractors

ROTARY AND CABLE TOOLS

ALPHABETICAL LISTING

A

Abb Drlg Co 300 Oil & Gas Bldg Wichita Falls Tex
Acacia Drlg Co Box 881 Tulsa Okla
Ace Drlg Co 1800 Republic Natl Bk Bldg Dallas Tex
E H Adams Drlg Co Box 1601 Midland Tex
Adkins Drlg Co 827 Milam Bldg San Antonio Tex
Akin & Dimock 714 Holliday St Wichita Falls Tex
Alan Drlg Co 807 Oil & Gas Bldg Wichita Falls Tex
Aldridge and Stroud Inc Box 962 Odessa Tex
Thomas H Allan 925 Union Center Wichita Kans
Allen Drlg Co 4410 Venable Ave Charleston 4 W Va
W C Allen Box 263 Oil City La
B F Allison Drlg Co 626 Patterson Bldg Denver Colo
American Drlg Corp Box 177 Graham Tex
Anderson Drlg Contr Box 167 Olney Ill
Duke Anderson Drlg Co Box 379 Oklahoma City Okla
Anschutz Oil Co Inc Box 1466 Casper Wyo
An-Son Drlg Co 3814 N Santa Fe Oklahoma City 18 Okla
Appell Petroleum Corp Box 330 Alice Tex
Arapahoe Drlg Co 1020 Petroleum Club Bldg Denver Colo
Ari-Kan Drlg Co Box 162 Great Bend Kans
Armstrong & Horn Drlg Co 640 Milam Bldg San Antonio 5 Tex
Arrow Drlg Co 407 Phillower Bldg Tulsa Okla
Ashby Drlg Co Ltd 738 Meadows Bldg Dallas Tex
Ayers & Burch Box 1915 Wichita Falls Tex

B

B & B Drlg Co Whitlash Mont
B B M Drlg Co 673 San Jacinto Bldg Houston 2 Tex
B J & M Drlg Co Ltd 160 S Fairfax Ave Los Angeles Calif
B-M Drlg Co Inc Box 5218 Bossier City La
Pernie Bailey 2309 Sage Rd Houston Tex
W C Baily Rt 1 Broken Arrow Okla
Baird & Pfeifer Drlg Co 316 Kittredge Bldg Denver Colo
Baker & Taylor Drlg Co 712 First Natl Bk Bldg Amarillo Tex
Dorris Ballew Inc Box 561 Natchez Miss
Bar-Lee Drlg Co Box 7264 Tulsa Okla
Barnes Core Drlg Co 1350 Roberts Ln Bakersfield Calif
Barnwell Drlg Co Inc Box 1748 Shreveport La
Barrett Petroleum Co 423 Masonic Bldg Shawnee Okla
Barry Well Drlg Co West Star Rt Fallon Nev
Basin Drlg Corp Box 1388 Duncan Okla
Robert M Bass Drlg Contr Box 471 Kilgore Tex
Bauman Drlg Co 510 Gulf States Bldg Dallas Tex
Bay City Drlg Co Inc Box 1389 Bay City Tex
Beard Drlg Inc 900 NE Military Dr San Antonio Tex
Beardmore Drlg Co 827 Beacon Bldg Wichita Kans
Beckman Inc Box 1524 Muskogee Okla
Bennett & Roberts Drlg Co Drawer 633 Russell Kans
Bennett & Roberts Drlg Inc Drawer 633 Russell Kans
Bennett Drlg Co 1381 E 26th St Tulsa 14 Okla
Bernhardt Drlg Co 2469 Grand River Detroit 1 Mich
Berry Drlg Co Box 67 Saint Jo Tex
L E Bever Drlg Co 1700 W Louisiana Midland Tex
Big Chief Drlg Co Box 8837 Oklahoma City 14 Okla
Big Horn Drlg Co Inc Box 2068 Casper Wyo
Big Seven Drlg Co 311 Wright Bldg Evansville Ind
Big '6' Drlg Co 225 Oil & Gas Bldg Houston 2 Tex
Big West Drlg Co 1505 Oil & Gas Bldg Ft Worth 2 Tex
Big X Drlg Co Inc 2905 First Natl Bldg Oklahoma City Okla
Bilbo-Redding Drlg Co Inc Box 21045 Houston Tex
Black Drlg Co 525 Petroleum Bldg Abilene Tex
Henry Black Drlg Co Inc Box 174 Midland Tex
Black Hills Drlg Co Inc 218½ W Main Newcastle Wyo
Blount Drlg Co Inc 114 Central Bldg Midland Tex
Bolin Oil Co & D H Bolin 1120 Oil & Gas Bldg Wichita Falls Tex
Boyd & Durst Drlg Contr Box 329 Alice Tex
E G Bradham First Natl Bk Bldg El Dorado Ark
Brannon & Murray Drlg Co Box 672 Coleman Tex
Brantly Drlg Co Inc Box 4935 Midland Tex
C E Brehn Drawer 618 Mt Vernon Ill
Brewster-Bartle Drlg Co Inc 1919 Bk of Southwest Houston Tex
Brinkerhoff Drlg Co Ltd 1001 Mobil Oil Bldg Calgary Alta Canada
Zach Brooks Drlg Co Box 31 El Dorado Ark
Brown & Martin Drlg Co Box 731 Gainesville Tex
Brown & Scarber Drlg Co Box 5131 Midland Tex
Curt Brown Drlg Co 516 Mayo Bldg Tulsa Okla
Brown Drlg Co Box 7217 Long Beach 7 Calif
Layton Brown Drlg Co Box 185 Woodsboro Tex
Brown Marine Drlg Co 1456 E Hill St Box 7217 Long Beach 17 Cal
Brownie Drlg Co 2212 Second Ave Lake Charles La
Harry T Bryant Drlg Co Ltd Box 13364 Houston 19 Tex
Bryant-Hayward Drlg Co Box 4627 Oklahoma City Okla
Al Buchanan Drlg Co 2113 Alamo Natl Bldg San Antonio Tex
Bueno Drlg Co 425 Continental Oil Bldg Denver Colo
Buick Drlg Inc 409 Wolcott Bldg Hutchinson Kans
Bullard Drlg Co Inc Melrose Bldg Houston Tex
A O Bullock Drlg Co Box 821 Casper Wyo
Burger Drlg Co Box 327 Coleman Tex
Butler County Drlg Co 506 Orpheum Bldg Wichita Kans
Butler-Johnson Inc Box 306 Shreveport La
Buzzini Drlg Co Petroleum Center San Antonio 5 Tex
B G Byars Power Drlg Co 319 Citizens Bk Bldg Tyler Tex

C

C & S Drlg Co 2308 Transit Tower San Antonio Tex
C B Drlg Co 323 Petroleum Bldg Abilene Tex
CBS Workover Co 1713 N Esperson Bldg Houston Tex
C K C Drlg Co 700 Oil & Gas Bldg Wichita Falls Tex
C N P Drlg Co 404 Staley Bldg Wichita Falls Tex
C-P Drlg Co Box 685 Pampa Tex
Cactus Drlg Corp of Tex Box 348 San Angelo Tex
Cactus Drlg Corp Ltd Box 853 Calgary Alberta Canada
Calvert Drlg Inc Box 552 Olney Ill
Camay Drlg Co Rocky Mt Div Suite 1130 Denver Club Bldg Denv Colo
Camden Drlg Co Box 1418 Corpus Christi Tex
Canadian River Drlg Co 424 Petroleum Bldg Amarillo Tex
Capitt Drlg Co 814-16 Union Center Wichita Kans
Frank Caraway Drlg Co Box 982 San Angelo Tex
Carmack Drlg Co 1008 Mile High Center Denver Colo
Carpenter-Trant Drlg Co 321 C A Johnson Bldg Denver 2 Colo
Carroll Drlg Co Inc Box 337 Farmington NM
Carter Drlg Co 1640 W 34th St N Wichita Kans
Carter-Jones Drlg Co Box 1597 Kilgore Tex
Casey & Montgomery Inc Box 1102 Bakersfield Calif
Casner & Bentz Box 666 Oildale Calif
Chambless-Rosen Drlg Co Box 4294 Oklahoma City 9 Okla
Chiles Drlg Co Box 949 Alice Tex
Cecil Chisler & Son Route 2 Fairview W Va
Choya Drlg Co Inc 500 W Illinois Midland Tex
Circle Drlg Co Inc 620 Pioneer Bldg Lake Charles La
Clark Drlg Co Box 1743 Billings Mont
Clark Fuel Prod Co Box 473 Mission Tex
R L Bob Clark Drlg Contr Box 1933 Kermit Tex
Don Clawson Drilling Co 125 W 19th St Ada Okla
Claypool Drlg Co Box 98 St Elmo Ill
Clegg & Hunt 715 Houston Club Bldg Houston Tex
Clinch Drlg Co Box 27 Hazelhurst Miss
Coastal Drlg Co 7300 La Hore Rd Bakersfield Calif
Collier Drlg Co Box 798 Artesia NM
Colorado Wyoming Drlg Co 1119 Mile High Center Denver Colo
Columbia Drlg Co 1207 C & I Life Bldg Houston 2 Tex
Comet Drlg Co Box 1143 OCS Lafayette La
Conrey Drlg Co 328 E Broadway Centralia Ill
Continental Drlg Co 414 Shell Bldg New Orleans La
Continental Shelf Drlg Corp 916 Richards Bldg New Orleans 12 La
Cook Drlg Co 2305 Continental Life Bldg Ft Worth Tex
Coon-Murphy Drlg Co 3272 Westheimer Houston Tex
Cooper Drlg Co 902 Staley Bldg Wichita Falls Tex
R A Cooper Drlg Co 711 Hulman Bldg Evansville Ind
Coral Drlg Co 6100 Camp Bowie Blvd Ft Worth Tex
Ceroco Drlg Co 2807 Mercantile Bk Bldg Dallas Tex

W C Cottris Broken Arrow Okla
Crawford Drlg Co Box 622 Shreveport La
Cree Drlg Co Inc Box 1821 Pampa Tex
Criswell Drlg Co Box 253 Arkansas City Kans
Cron & Gracey Corp 1100 Houston Club Bldg Houston Tex
Jess P Cross Drlg Contr 1216 Texas Graham Tex
Crow Drlg & Prod Co 2000 Beck Bldg Shreveport La
Crow Greyhound Drlg Co Inc Box 7334 Shreveport La
Milton Crow Inc 420 Commercial Natl Bk Bldg Shreveport La
Crowe Drlg Co 211 Perkins Bldg Duncan Okla
Sam E Crump Drlg Co 2404 Rankin Hwy Midland Tex
Harry L Cullet Purefoy Hotel Talladega Ala
Cummins Drlg Co Altamont Ill

D

D & J Drlg Co Rt 2 Box 219-A Okemah Okla
D & M Drlg Co Inc Box 247 Great Bend Kans
D-D Drlg Co Box 667 Olney Tex
D-K Drlg Co Box 866 Cortez Colo
Danforth Drlg Co 418 Kennedy Bldg Tulsa Okla
R W Darden Drlg Co Box 574 Olney Tex
R A Davenport Drlg Contr 211 Perkins Bldg Duncan Okla
Davidson Drlg Co Inc 1004 Continental Life Bldg Ft Worth Tex
Davis & Bates Inc Milam Bldg San Antonio Tex
Edgar Davis Drlg Co 717 Citizens Bk Bldg Abilene Tex
Harvey Davis & Robt H Thompson Co 1731 28th St Bakersfield Cal
Davon Drlg Co Box 1586 Oklahoma City Okla
Dearing Inc Box 655 Dallas Tex
Delaney Drlg Co Box 881 Ada Okla
M J Delaney Co 910 Dallas Fed Savings Bldg Dallas 1 Tex
Del Mar Drlg Co 409 Oil Industries Bldg Corpus Christi Tex
Delta Drlg Co Box 2012 Tyler Tex
Delta Overseas Drlg Co (Rome Italy) Box 2012 Tyler Tex
Denver Drlg Corp Box 669 Odessa Tex
W L Dillier Box 341 Casey Ill
Dixie Drlg Co Inc 1712 Commerce Bldg Houston 2 Tex
Dixon Drlg Co Box 2320 Abilene Tex
Doak Drlg Co Box 1108 Bristow Okla
Doc Drlg Corp Blackie Drlg Co Inc Neva-Andre Drlg Corp 210 Willow St Franklin La
Donnell Drlg Co 605 Texas Bk Bldg Dallas 2 Tex
Douglas Drlg Co Box 748 Oildale Calif
Drillers Inc 2005 Adolphus Tower Dallas Tex
Drlg & Expl Co Inc Box 35366 Dallas Tex
Drlg & Expl Co of Delaware Inc Box 35366 Dallas Tex
Drlg & Prod Co 2907 L St Bakersfield Calif
Drill Well Oil Co 1502 8th St Wichita Falls Tex
Dual Drlg Co 606 City Natl Bk Bldg Wichita Falls Tex
Dublin-Kiel 203 Robertson Bldg Wichita Falls Tex
Dudley & Heath Drlg Co Box 428 Stillwater Okla
B A Duffy Drlg Co Rm 100 Crescendo Bldg Abilene Tex
Dugger & Herring Drlg Co 203 Crescendo Bldg Abilene Tex
N V Duncan Drlg Co 303 Oil and Gas Bldg Oklahoma City Okla
Dunnam & Wyant Drlg Co 816 N Jordan Liberal Kans
Durham Drlg Co Inc Box 204 Midland Tex
Dyer Drlg Co Box 338 Casper Wyo

E

E & H Drlg Co Box 1058 Graham Tex
E L & M Drlg Co Box 29 Holdenville Okla
T T Eason Co Div of Eason Oil Co 1211 Colcord Bldg Okla City 2 Okla
Eastern Drlg Inc Box 291 Carmi Ill
Eastland Drlg Co 806 Continental Life Bldg Ft Worth Tex
Eatmon Drlg Co Box 535 Kimball Neb
B F Edington Drlg Co Inc 447 N Market Shreveport La
Edwards & Bissett Inc 1912 N Esperson Bldg Houston Tex
Harry L Edwards Drlg Co Box 6825 Houston 5 Tex
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Errol Elkins Drlg Co 460 Rio Grande St Eagle Pass Tex
Ellis Drlg Corp Box 393 Colorado City Tex
Empire Drlg Co 509 Continental Bldg Dallas Tex
Empire Drlg Co 650 Fourth Natl Bk Bldg Wichita Kans
Empire States Drlg Corp 1020 Simms Bldg Albuquerque N M
Ewing Drlg Co Box 807 Breckenridge Tex
Exeter Drlg Co Republic Natl Bk Bldg Dallas 1 Tex
Exploration Drlg Co 607 Natl Bk of Tulsa Bldg Tulsa Okla

F

Fain-Porter Drlg Corp 2410 First Natl Bldg Oklahoma City Okla
Fairman Drlg Co Hammersley Fork Pa
Falco Drlg Co Inc Box 1255 Alice Tex
Falcon Seaboard Drlg Co Pan American Bldg Tulsa Okla
Felderhoff Bros Drlg Co Box 87 Muenster Tex
Fen-Par Expl Co Inc Box 282 Grand Haven Mich
Field Drlg Co 1900 Milam Bldg San Antonio Tex
Fitzpatrick Drlg Co 803 Wilson Tower Corpus Christi Tex
Fleeger Drlg Inc 271 Meadows Bldg Dallas 6 Tex
Flournoy Drlg Co Box 1578 Alice Tex
Flournoy-Haston Drlg Co Inc 1005 Davis Ardmore Okla
Folk Drlg Co 614 Main Yukon Okla
Fortenbery Drlg Co Inc Box 273 Natchez Miss
Fortune Drlg Corp Petroleum Bldg San Angelo Tex
C J Foster Drlg Co Inc Box 657 Richmond Tex
Foster Drlg Co Inc Box 751 Cushing Okla
4-J Drlg and Well Serv Co Box 471 Drumright Okla
Armstrong Fowler Inc 929 Oleander Bakersfield Calif
Fowler Drlg Co 2450 Orange Ave Long Beach Calif
Frankfort Oil Co Drlg Div Box 747 Dallas Tex
Frank Frawley Drlg Co 823 S Detroit Tulsa 3 Okla
Lloyd R French Co 506 V & J Tower Midland Tex
Frio Drlg Inc 508 Driscoll Bldg Corpus Christi Tex
Fryer & Hanson Drlg Co 2520 Republic Natl Bk Bldg Dallas Tex

G

Gabbert-Jones Drlg Co 514 Orpheum Bldg Wichita Kans
C S Garber & Sons Inc Boyertown Pa
Gardner Bros Drlg Co Inc 1718 Davis Bldg Dallas Tex
Buster Gardner Drlg Co Inc Box 281 New Iberia La
Garvey Drlg Co Route 2 Great Bend Kans
Gary Drlg Co Box 58 Oil City La
General Drlg Co Colcord Bldg Oklahoma City Okla
General Geophysical Co 750 Houston Club Bldg Houston 2 Tex
General Well Drlg Inc Box 1315 Alice Tex
Gibson Drlg Co Box 1540 Kilgore Tex
Gilger Drlg Co 831 N Esperson Bldg Houston 2 Tex
Glenn Gillespie & Sons Box 907 Cushing Okla
W Hugh Glass Drlg Co 2612 S Third Austin Tex
C G Glasscock Drlg Co 1601 Wilson Tower Corpus Christi Tex
Glasscock-Wilson Inc 1604 Beck Bldg Shreveport La
Glendale Drlg Co 906 Hales Bldg Oklahoma City Okla
Glenn Drlg Co 38 Kennedy Bldg Tulsa Okla
Gee Drlg Co Box 5 Perry Okla
Goff-Leeper Drlg Co Box 1749 Ardmore Okla
Gold-Mar Drlg Co Box 732 Dewar Okla
Goldsmith Drlg Co Box 750 Duncan Okla
Goll Graves & Mechling Inc 205 Bearinger Bldg Saginaw Mich
Gordon Drlg Co Box 15 Mt Pleasant Mich
Gore Drlg Co Box 515 Albany Tex
T V Gorman Drlg Contr 621 Staley Bldg Wichita Falls Tex
H O Grace Drlg Co 632 Wichita Natl Bk Bldg Wichita Falls Tex
Jack Grace Drlg Contr 1009 City Natl Bk Bldg Wichita Falls Tex
Luke Grace Drlg Co 1020 Oil & Gas Bldg Wichita Falls Tex
Gracey-Heliums Corp 410 S Coast Bldg Houston 2 Tex
Graham & Klassen Drlg Co Inc 4715 Crenshaw Blvd Los Angeles Cal
Burdette Graham 804 Driscoll Bldg Corpus Christi Tex
Graham Drlg Co 2nd Floor First St Bk Bldg Temple Okla
Graham-Michaelis Oil Co 211 N Broadway Wichita 7 Kan
Grannell Drlg Co Box 583 Casper Wyo
John Grappe Drlg Co Box 1186 Levelland Tex
Graves Drlg Co Box 583 Ardmore Okla
Gray Drlg Co 220 Wichita Natl Bk Bldg Wichita Falls Tex
Graytex Drlg Co 300 Oil & Gas Bldg Wichita Falls Tex
Green & Dreblow Drlg Co Box 1057 Bakersfield Calif
Greenland Drlg Box 518 Great Bend Kans
Greenwood Petroleum Management Inc Eureka Kans
Grey Wolf Drlg Co 1506 Bk of the Southwest Houston 2 Tex
Guadalupe Drlg Co 2505 Princeton Ave Midland Tex
Roy Guffey Drlg Co 5543 Yale Blvd Dallas 6 Tex
Gulf Coast Drlg & Expl Inc Box 2367 Choctaw Sta Laurel Miss
Henry Gwaltney Drlg Co Box 289 Washington Ind

H

Hack Drlg Co Box 1636 Abilene Tex
John S Hagestad Drlg Co 3224 Gulf St Bakersfield Calif
Halbert Drlg Co 507 Citizens Bk Bldg Tyler Tex
O E Hall Drlg Co 2008 Continental Natl Bk Bldg Ft Worth Tex
Hamilton Investment Co 1220 Hamilton Bldg Wichita Falls Tex
Hamilton-Powell Drlg Co Inc 1220 Hamilton Bldg Wichita Falls Tex

Hamman Oil & Ref Co Box 13028 Houston 19 Tex
Haney & Williams Drlg Co 3500 Cherry Ave Long Beach 7 Calif
Hap Drlg Co 501 First Natl Bldg Oklahoma City Okla
F E Hargraves & Sons Drlg Co Box 573 Oil City La
Harkins & Co Box 1490 Alice Tex
Harper-Turner Drlg Co 904 Hightower Bldg Oklahoma City Okla
Harrell Drlg Co 1228 Bk of Southwest Bldg Houston 2 Tex
Harris Drlg Co Box 699 Grayville Ill
John W Harris Drlg Co 525 Wichita Natl Bk Bldg Wichita Falls Tex
John Haseman Inc 419 Wilson Bldg Corpus Christi Tex
J W Hastings Drlg Co 722 Wichita Natl Bk Bldg Wichita Falls Tex
H F Hatcher & Son Drlg Co Box 164 Smackover Ark
Hatfield Drlg Co Inc 1611 N "H" St Midland Tex
Hawkins-Wilkins Prod Co 373 San Jacinto Bldg Houston Tex
Win Hawkins Drlg Co 373 San Jacinto Bldg Houston 2 Tex
Hayes & Sprague Inc 612 S Flower Los Angeles Calif
Hayward Drlg Co Box 295 Enid Okla
John Heard & Co Inc Rm 4 Elm Oil Bldg Tulsa Okla
Heathman Oil 1019 E 2nd St Wichita 7 Kans
Helmerich & Payne Inc First Natl Bldg Tulsa Okla
Henderson Drlg Corp 2208 N Esperson Bldg Houston 2 Tex
Henson Drlg Co Box 2192 Abilene Tex
The Herb Expl Co 342 Lexington Ave Abilene Tex
Herndon Drlg Co Drawer 489 Tulsa Okla
B M Hester Box 2588 Wichita Falls Tex
Hewit-Gulick Drlg Co 2555 1st Natl Bk Bldg Denver 2 Colo
Highland Drlg Co Box 671 Odessa Tex
Hilburn Industries Inc Ricou-Brewster Bldg Shreveport La
J E Hillier Box 67 Pleasanton Tex
C F Hills Drlg Co Box 2158 Pampa Tex
Chas E Hipp Box 26 Graham Tex
Hissom Drlg Co 1327 Wilco Bldg Midland Tex
Hoagland Drlg Co Inc 108 N Lincoln St Robinson Ill
Holliman Drlg Co 712 Fidelity Union Life Bldg Dallas Tex
Holm Drlg Co Box 7246 Tulsa Okla
Holmes Drlg Co 1045 San Jacinto Bldg Houston Tex
Slats Honeymon Drlg Co 1310 Liberty Bk Bldg Oklahoma City Okla
R L Horn & Son Drlg Co Pawnee Okla
Hose-Austin Drlg Corp Box 1067 Casper Wyo
Houchins Drlg Co Box 388 Mt Carmel Ill
Houston Oil Well Serv Co 504 Waugh Dr Houston 19 Tex
Howell & Howell 1610 Life of America Bldg Dallas Tex
Hull Oil Co 214 Panhandle Bldg Wichita Falls Tex
Hunter Bros 509 First Natl Bldg Wichita Falls Tex
T F Hunter Estate 509 First Natl Bldg Wichita Falls Tex
Hupp & Hume Box 616 Owensboro Ky
I J Huval Well Serv Co Box 261 Pampa Tex
Hylton Drlg Co 716 Eye St Bakersfield Calif

I

Inca Drlg Co 709 Houston Club Bldg Houston Tex
Indian Drlg Co Box 42 Tulsa Okla
Donald T Ingling 623 First Natl Bk Bldg Wichita 2 Kans
Irish Drlg Co Inc Box 225 Eastland Tex
Isern Drlg Co Box 45 Ellinwood Kans
Ivy Drlg Co 1705 Burton Way Bakersfield Calif

J

J & J Drlg Co Box 150 Holdenville Okla
Jackson Oil Co Box 147 Longview Tex
Jackson Drlg Co Box 1388 Duncan Okla
Jal Oil Co Inc Box 1744 Midland Tex
Charles M Jameson Box 532 Vernal Utah
Jennings Drlg Co 612 City Natl Bk Bldg Wichita Falls Tex
Jett Drlg Co Inc Box 1832 Shreveport La
Johnn Drlg Co 711 Fair Bldg Ft Worth Tex
Al Johnson Drlg Co Rt 12 Box 440 Oklahoma City 10 Okla
Johnson-Bates Drlg Co Box 425 Konawa Okla
Johnson Drlg & Serv Co Box 3 Magnolia Ark
Johnson Drlg Co 634 Petroleum Bldg Tyler Tex
Fred Johnson Drlg Co 2790 Cherry Ave Long Beach Calif
Johnson-Gadbois Drlg Co 200 Petroleum Bldg Abilene Tex
Don Johnston Drlg Co 825 Petroleum Club Bldg Denver Colo
Jonco Drlg Co Box 1214 Seminole Okla
Buck Jones Drlg Co Box 1085 McCamey Tex
Jones Well Serv Co Box 1547 Abilene Tex
Woody Jones Drlg Co 408 E Main St Olney Ill
Justiss-Mears Oil Co Box 396 Jena La
Justrite Serv Co 709 Houston Club Bldg Houston Tex

K

K & E Drlg Inc 719 Union Center Bldg Wichita 2 Kans
K & S Drlg Co First Natl Bldg Bartlesville Okla
Karper & Glass Box 149 Graham Tex
Kaybert Drlg Co Box 175 Konawa Okla
Kee & Simpson Drlg Co 2975 Wilshire Blvd Los Angeles 5 Calif
K L Kellogg & Sons Box 510 Compton Calif
Kelly Drlg Co Box 1126 Houma La
Kendall-Davis Drlg Co Inc 201 SE 1st St Evansville Ind
Kent Drlg Co Box 2555 Salt Lake City Utah
Keoughan Drlg Co Box 9368 Fort Worth 7 Tex
Kendrick Bros Box 402 Vivian La
Kent & Preston 425 Sayles Blvd Abilene Tex
Kern Drlg Co Inc Box 936 Magnolia Ark
Kerr-McGee Oil Industries Inc Kerr-McGee Bldg Okla City Okla
Kersey & Co Box 305 Artesia N Mex
Keyes Drlg Co Box 1108 Roswell N Mex
Carl B King Drlg Co of Tex Box 270 Midland Tex
Kirby Oil Ind 5107 Center St Omaha 6 Neb
Hugh Kirkpatrick Inc Box 312 Mission Tex
Kirkpatrick Oil Co 1300 N Broadway Oklahoma City Okla
A F Knappenberger & A B Henley Box 1139 Graham Tex
A F Knappenberger Drlg Co Box 1139 Graham Tex
Knight Drlg Co Box 1332 Bakersfield Calif
Carl Knox Drlg Co Coweta Okla
Kullberg & Otthouse Inc Box 967 Cut Bank Mont

L

L & F Drlg Co Box 1468 Bakersfield Calif
Ralph G Ladd Box 5 Haskell Okla
LaMac Oil Co 104 S Main St Taylorville Ill
La Mance Drlg Co Box 4457 Midland Tex
Larco Drlg Co Box 3499 Jackson Miss
Howard C Lasiter Drlg Co Box 172 Grandfalls Tex
Lauderdale & Straughan Drlg Co 328 F & M Bk Bldg Abilene Tex
Laughlin-Porter Drlg Co Inc Petroleum Life Bldg Midland Tex
Layton and Newell Drlg Co 1505 Oil & Gas Bldg Ft Worth Tex
Leatherwood Drlg Co Box 925 Jacksboro Tex
LeCuno Oil Corp Box 804 Jefferson Tex
Lee Drlg Co 1007 Philtower Bldg Tulsa Okla
D B Lesh Drlg Co Box 505 Mattoon Ill
Lewis Bros Inc 320 Mile High Center Denver 2 Colo
Lewis Drlg Co 915 Union Center Wichita Kans
Will I Lewis Drlg Co 425 Continental Oil Bldg Denver Colo
Lincoln Drlg Co 403 Oil & Gas Bldg Oklahoma City Okla
Ted Lindsay Drlg Contr Box 190 Mt Vernon Ill
M M Lindsey Drlg Co 4748 Airline Hwy Baton Rouge La
Lin-Mour Drlg Co Oil & Gas Bldg Wichita Falls Tex
Livermore Drlg Co 406 Lubbock Natl Bk Bldg Lubbock Tex
Llano Drlg Co 301 V & J Tower Bldg Midland Tex
Lloyd Drlg Co Box 355 Taft Calif
Lofton Oil Co 707 Oil & Gas Bldg Wichita Falls Tex
Lohmann-Johnson Drlg Co Inc 320 Indiana Bk Idg Evansville Ind
Lohmann-Johnson Oil Co Inc 320 Indiana Bk Bldg Evansville Ind
Lohmann-Johnson Drlg Co Ltd 208 Bamlett Bldg Calgary Alberta Can
Lomax Drlg Co Box 584 Midland Tex
Charles E Long Jr Inc Box 961 Midland Tex
Longhorn Drlg Corp Box 546 Three Rivers Tex
Low Drlg Co Box 1112 Cisco Tex
Lowe Drlg Co Box 832 Midland Tex
Lynn Drlg Co 1403 Natl Bk Tul Bldg Tulsa Okla

M

M & J Inc 3612 W Wall Midland Tex
MIM Drlg Corp 1401 Majestic Bldg San Antonio Tex
Mac Drlg Co Box 2972 Houston Tex
Macrate Prod Co 3341 Cherry Ave Long Beach 7 Calif
R L Manning Co 318 Continental Oil Bldg Denver Colo
Mardale Drlg Co Box 107 Duncan Okla
Marhill Oil & Gas Co Inc 523 Frederica St Owensboro Ky
Marine Drlg Inc 212 Balter Bldg New Orleans La
Maritzky & Bibby Box 509 Homer La
Lubie Martin Drlg Co 2052 Harvard Houston Tex
Mast Drlg Inc 138 W 7th St Russell Kans
Maxwell Drlg Co Box 846 Coleman Tex
M Mazzarino 104 W Broadway Centralia Ill
Meadows & Walker Drlg Co 500 San Jacinto Bldg Houston 2 Tex
Melco Drlg Co Box 1360 Seminole Okla
Mercury Drlg Corp 1205 Beck Bldg Shreveport La

Meredith & Co 1418 Bk of the Southwest Bldg Houston Tex
Meredith Drlg Co 419 City Natl Bldg Wichita Falls Tex
Ward S Merrick Box 971 Ardmore Okla
Mesker Drlg Co 1129 E 15th St Tulsa Okla
Metzger Drlg Co Tulsa Okla
Midland Drlg Co 410 W Ohio Midland Tex
Midwestern Drillers Inc 1206 Mid-Continent Bldg Tulsa 3 Okla
Milam Drlg Co 1814 Alamo Natl Bldg San Antonio Tex
J Conley Miles Drlg Co Box 1791 Abilene Tex
Milestone Drlg Co Box 314 Midland Tex
Milhoan Drlg Co Box 948 Tulsa Okla
Miller Bros & Bowling Box 611 Alice Tex
Gene Miller Inc Box 238 Lawrenceville Ill
J E Miller Drlg Contr Box 1581 Abilene Tex
Alfred Mir Drlg Co Rt 4 Broken Arrow Okla
Miracle-Fifer Drlg Co 1636 Welton St Denver 2 Colo
Monroe Drilling Co Inc Box 490 Monroe, La
Montgomery Drlg Co Box 747 El Dorado Ark
J S Montgomery 103 NW 44th St Oklahoma City Okla
Moore & Moore Drlg Co Box 29 Abilene Tex
Lamar H Moore Drlg Co Box 29 Abilene Tex
Mora Drlg Co 1908 First Natl Bldg Tulsa Okla
Moran Bros Inc 1200 Oil and Gas Bldg Wichita Falls Tex
E F Moran Inc 1805 Natl Bk of Tulsa Bldg Tulsa 3 Okla
E W Moran Drlg Co 500 First Natl Bk Bldg Wichita Falls Tex
Moran Bros Inc 1200 Oil & Gas Bldg Wichita Falls Tex
Dave Morgan Drlg Co Box 820 Blackwell Okla
Pete Morris Drlg Co Box 733 Ada Okla
Morrison Drlg Co Inc Box 583 Casper Wyo
Dale Mount Drlg Inc 1155 Mercantile Dallas Bldg Dallas 1 Tex
Mountain States Drlg Co Inc 622 Patterson Bldg Denver Colo
Movible Offshore Co 743 San Jacinto Bldg Houston 2 Tex
Murfin Drlg Co 617 Union Center Wichita 2 Kans
Murphy & McKernan Box 169 Pampa Tex
Musgrove Petroleum Corp 801 Union Center Wichita Kans
Myers Drlg Serv 2117 Bank St Bakersfield Calif

Mc

McAlester Fuel Co Box 210 Magnolia Ark
Gabe McCall Drlg Co Box 2068 Casper Wyo
McCutchen & Graham 409 Oil & Gas Bldg Wichita Falls Tex
McDaniel & Beecherl Drlg Co 607 Davis Bldg Dallas Tex
B L McFarland Drlg Corp 3612 W Wall Midland Tex
B L McFarland Inc 3612 W Wall Midland Tex
W H McGarr Industries Box 472 Eagle Pass Tex
B M McGraw Drlg Contr 4412 N Western Oklahoma City Okla
McKenzie Drlg Co 837 Wilson Bldg Corpus Christi Tex
McQueen & Stout Drlg Co 1113 Ft Worth Natl Bk Bldg Ft Worth Tex

N

Neal Drlg Co Box 3186 Victoria Tex
Needham Drlg Co Box 1285 Artesia N Mex
Nemaha Oil Co Mercantile Bk Bldg Dallas Tex
Newton Drlg Co Box 1104 Coalinga Calif
Nicklos Drlg Co 518 City Natl Bk Bldg Houston Tex
Nichols Drlg Co Box 1032 Duncan Okla
The Noah Petroleum Co Box 192 Albion Ill
George Noland Drlg Co Inc 823 S Detroit Ave Tulsa 20 Okla
Norman Drlg Corp 1141 Butternut St Abilene Tex
Norwood Drlg Co 700 Wichita Natl Bk Bldg Wichita Falls Tex
Nowery Drlg Co Inc 5904 Fairfield Shreveport La
Nuckolls-Bell Drlg Co 1255 First Natl Bldg Oklahoma City 2 Okla
Nye & Snell Drlg Co 208 Patterson Bldg Denver Colo

O

Ocean Drlg & Expl Co 2475 Canal St Caribe Bldg New Orleans La
Oien Oil Corp Box 2235 Cut Bank Mont
Olds & Wrather Drlg Co Box 113 Casper Wyo
Olds & Wrather Oil Co Box 113 Casper Wyo
Olds Oil & Chem Corp Box 72 Mt Carmel Ill
R Olsen Liberty Bk Bldg Oklahoma City Okla
W B Omohundro Box 774 Wichita Falls Tex
O'Neal-Garvin Drlg Co Box 1289 Duncan Okla
Oney Drlg Co Box 425 Graham Tex
Ormand Bros Drlg Co Box 1469 Odessa Tex
Ormand Drlg Co Inc Box 1469 Odessa Tex
O'Rourke-McGirl Drlg Co 632 Natl Bk of Tul Bldg Tulsa Okla
Overby Drlg Co Inc Box 248 Nowata Okla
Owen Drlg Co Box 1423 OCS Lafayette La

P

Paco Petroleum Corp Box 347 Mt Carmel Ill
Paine Drlg Co 301 Insur-O-Medic Bldg Dallas Tex
Pan-Tex Drlg Co 316 Henderson Blvd Kilgore Tex
Parker Drlg Co 418 Natl Bk of Tulsa Bldg Tulsa Okla
Howard Parker Co 1103 Bk of Southwest Bldg Houston Tex
Patton Drlg Co Inc Orpheum Bldg Wichita Kans
Payne Bros Drlg Co 1411 10th St Lawrenceville Ill
Willard Pease Drlg Co Box 1532 Grand Junction Colo
Pegg Bros Drlg Co 1204 Natl Bk of Commerce Bldg San Antonio Tex
Penrod Drlg Co 418 Market St Shreveport La
Pep Drlg Co 1008½ Main St Mt Vernon Ill
Perforaciones Delta C A Apartado 9138 Caracas Venezuela
Perkins Bros Drlg Co Box 1232 Duncan Okla
Perrine & Perrine Drlg Contr Box 87 Salem Ill
Petrolex Inc 361 Palmtag Hollister Calif
H F Pettigrew Drlg Account 836 Republic Natl Bk Bldg Dallas Tex
Pico Drlg Co Box 512 Breckenridge Tex
Louis Pitcock Drlg Co Box 25 Graham Tex
C C Pollard Box 65 Ft Stockton Tex
Pool & Gerlich Drlg Co Box 1940 San Angelo Tex
Fred Pool Drlg Co 3106 Lockheed Midland Tex
Poteet Wyser & Eckles Inc Box 508 Holdenville Okla
Powell Drlg Co 412 Union Center Bldg Wichita Kans
Graham Powell Drlg Co 129 N Sycamore St Centralia Ill
Prairie Drlg Co Box 2068 Casper Wyo
Precision Drlg Co Ltd 1134 Eighth Ave W Calgary Alberta Canada
Price-Sitton Drlg Co 406 Lubbock Natl Bk Bldg Lubbock Tex
Prime Drlg Co 814-16 Union Center Wichita Kans
Prince Marine Drlg & Expl Co 434 Bk of SW Bldg Houston Tex
Princeton Mining Co 111 N 7th St Terre Haute Ind
Producers Drlg Co Inc 927 Natl Bk of Com Bldg New Orleans La
Pyburn Drlg Co Box 4276 Shreveport La

Q

Quaker Drlg Co Inc 1100 Bitting Bldg Wichita 2 Kans

R

R-G Drlg Co 403 City Natl Bk Bldg Wichita Falls Tex
Frank Raiborn Drlg Co 35 Garden Rd San Angelo Tex
Ramey Well Serv Suite 401P Robertson Bldg Wichita Falls Tex
G H Ray Well Serv Box 68 Cement Okla
Reading & Bates Co de Venezuela 1502 Philtwr Bldg Tulsa 3 Okla
Reading & Bates Offshore Drlg Co 1502 Philtwr Bldg Tulsa 3 Okla
Reagan Drlg Co 1576 Carol Lane Wichita Falls Tex
Reaves Drlg Co Inc Box 32 Cushing Okla
Red River Drlg Co Cook Bldg Breckenridge Tex
Reed Drlg Co Box 477 Lamesa Tex
Reed Drlg Co Inc 1209 Atlas Bldg Tulsa Okla
Reserve Drlg Co Inc Drawer 1612 Casper Wyo
Reserve Drlg Co Inc 625 Union Center Bldg Wichita 2 Kans
Revier Drlg Co 208 City Natl Bk Bldg Wichita Falls Tex
Rheay & Reynolds Drlg Co 404 Petroleum Bldg Abilene Tex
Rhodes & Hicks Drlg Corp Box 1395 Alice Tex
Rhodes Drlg Co Box 239 Abilene Tex
Rimrock-Tidelands Inc 1315 Gravier Suite 1103 New Orleans La
The R W Rine Drlg Co 420 Union Center Wichita Kans
C M Roberson Drlg Co 418 Market St Shreveport La
Robinson Bros Drlg Co Box 430 Borger Tex
Robinson Drlg Co Box 153 Abilene Tex
Robinson Drlg Co Box 970 Colorado City Tex
Robinson-Wehmeyer Drlg Co 470 San Jacinto Bldg Houston Tex
Rocket Drlg Co 2099 E 27th St Long Beach Calif
Rocky Mountain Drlg Co 550 S Flower St Los Angeles Calif
Roden & McRae Drlg Corp Box 2286 Casper Wyo
D L Rose Drlg Contr Box 518 Albany Tex
Don M Rounds Drlg Co Inc 925 Petroleum Club Denver 2 Colo
Rowan Drlg Co Inc Drawer 12247 Ft Worth 16 Tex
J W Rudy Box 684 Clay City Ill
Ruhl Drlg Co Inc 1621 Bk of Southwest Bldg Houston 2 Tex
Rupp-Ferguson Oil Co 522 Union Center Bldg Wichita Kans
Russell & Russell Drlg & Prod 621 Lindsay St Gainesville Tex
Paul F Rutledge Box 2239 Santa Fe N Mex

S

Sage Drlg Co Inc 1100 Bitting Bldg Wichita 2 Kans
St John Drlg Co Box 639 Ballinger Tex
San Juan Drlg Co Box 728 Farmington N Mex
Santa Fe Drlg Co Box 310 Whittier Calif

Santa Rosa Drlg Co Box 633 Apple Valley Calif
Schafer Drlg Co 2400 Liberty Bk Bldg Oklahoma City Okla
J B Schick Drlg Co 510 Petroleum Bldg Abilene Tex
Schimmel Drlg Co 2121 Alamo Natl Bldg San Antonio Tex
A L Schlaikjer Box 761 Newcastle Wyo
Schoenfeld-Hunter-Kitch Drlg Co 812 Kennedy Bldg Tulsa 3 Okla
Schulz & Brannan Drlg Co 621 Staley Bldg Wichita Falls Tex
Scooter's Drlg Serv 1215 Sklar Bldg Shreveport La
A B See Drlg Co Inc 206 Petroleum Bldg Abilene Tex
Seiboldt Drlg Co 106½ N Harrison Cushing Okla
Seran & Howard Drlg Co Box 110 Okemah Okla
SeReBee Drlg Co Inc 422 Union Natl Bk Bldg Wichita Kans
Service Drlg Co 515 Kennedy Bldg Tulsa Okla
Harold Shappell Drlg Co 316 City Natl Bldg Wichita Falls Tex
Sheets & Walton Drlg Co Box 152 Breckenridge Tex
Shelley-Miller Drlg Co 205 Miller Bldg Wichita Kans
Sherin Drlg Co Inc 1709 First Natl Bldg Oklahoma City Okla
Shields Drlg Co Inc Shields Bldg Russell Kans
Shields Oil Producers Shields Bldg Russell Kans
Shoreline Drlg Co Inc 1203 Beck Bldg Shreveport La
Sills Drlg Co 1350 Roberts Ln Bakersfield Calif
Skinner & McDougal Drlg Co Box 8774 Oklahoma City Okla
Skipper Drlg Co Box 511 Cushing Okla
Don Slape Drlg Co Box 432 Olney Ill
Smallwood & Son 3657 E Kiest Blvd Dallas Tex
Smith & Breyer Suite 154 Meadows Bldg Dallas 6 Tex
B B Smith Inc Box 2876 Midland Tex
Darrell W Smith Co Box 1105 Midland Tex
James Smith Drlg Contr Box 33 Mertzon Tex
K Smith Cable Tools 1801 Van Buren Great Bend Kans
Sojourner Drlg Corp Box 679 Abilene Tex
Sooner Drlg Co 412 Federal Natl Bk Bldg Shawnee Okla
Southeastern Asia Drlg Co 901 Employers Ins Bldg Dallas Tex
Southeastern Drlg Corp 901 Employers Ins Bldg Dallas Tex
Southland Drlg Co 435 Milam Bldg San Antonio Tex
South States Drlg Co Box 147 Longview Tex
J D Sprecher Box 299 Casper Wyo
Steen Drlg Co 619 West Bldg Houston Tex
Stewart & Gouger Drlg Co 505 Alamo Natl Bldg San Antonio 5 Tex
Stice Drlg Co Box 678 Beeville Tex
Stouder Drlg Co 208 SE Riverside Dr Evansville Ind
Harold L Strader Drlg Co 3901 Mt Vernon Houston 6 Tex
Strait Drlg Inc Box 90 Eldorado Kans
C W Strotman Drlg Co 620 S 30th St Mattoon Ill
Stroube Drlg Co Box 730 Corsicana Tex
The Sun Drlg Co 2975 Wilshire Blvd Los Angeles 5 Calif
Sunnyland Contracting Co Inc Box 388 Rayne La
Sutton Drlg Co Box 6446 San Antonio Tex
Symons Drlg Co 999 Houston Club Bldg Houston 2 Tex

T

T & H Corp 111 N 7th St Terre Haute Ind
Target Drlg Corp 421 Mayo Bldg Tulsa Okla
Taylor Expl Co Inc 2118 Welch Ave Houston Tex
W P Taylor Drlg Co 1429 Bk of the Southwest Houston Tex
Temple Drlg Co Inc 320 Indiana Bk Bldg Evansville Ind
Terminal Drlg & Prod Co 1240 Blinn Ave Wilmington Calif
Texas Drlg Co Box 183 Monahans Tex
Texas R F O Inc 421 Meadows Bldg Dallas 6 Tex
Tex-Mex Drlg 1211 Fidelity Union Life Bldg Dallas Tex
Theiss Drlg Co 740 West 5th Ft Worth Tex
Thomas & Billups Drlg 809 Citizens Bk Bldg Abilene Tex
A W Thompson Inc Box 2524 Houston Tex
Thrasher Drlg Co 1602 Beck Bldg Shreveport La
Tibbits Drlg Co 226 Oil & Gas Bldg Wichita Falls Tex
Timberland Expl Co 1069 San Jacinto Bldg Houston 2 Tex
Tolson Drlg Co 213 Triangle Bldg Pawhuska Okla
J C Trahan Drlg Contr Inc 1203 Beck Bldg Shreveport La
Transit Corp 1516 Liberty Bk Bldg Oklahoma City Okla
Travis Drillers Inc Box 1097 Austin Tex
Treasure State Drlg Co Box 1712 Great Falls Mont
Triad Drlg Co 119 Featherston Bldg Wichita Falls Tex
Trimble Drlg Co Inc Box 459 Magnolia Ark
Trio Drlg Co 3013 Nussbaumer Dallas 26 Tex
Triple S Drlg Co Broken Arrow Okla
Tri-Service Drlg Co Box 1785 Midland Tex
Triton Drlg Co Inc Box 22282 Houston 27 Tex
Troop Drlg Co Box 145 St Elmo Ill
True Drlg Co Drawer 1612 Casper Wyo
Tucker Drlg Co Box 1876 San Angelo Tex
Goal Tullous & Co 306 Leggett Bldg Midland Tex
Turnbull & Zoch Drlg Co Box 2248 Corpus Christi Tex
Turner & West Box 65 Stamford Tex
C D Turner Drlg Co 501 Permian Bldg Big Spring Tex
Twinoak Drlg Co 210 S Morton Okmulgee Okla

U

U & E Drlg Co Box 323 Sullivan Ind
Rip C Underwood 553 First Natl Bk Bldg Amarillo Tex
Union Rotary Corp 1104 N Mission St Mt Pleasant Mich
Unit Drlg Co Box 599 Bristow Okla
United Drlg Co 8750 Holloway Dr Los Angeles 46 Calif
Urice Drlg Co 615 Ft Worth Club Bldg Ft Worth Tex

V

V & C Drlg Co Refugio Tex
VS & S Drlg Co 1004 Ridgley Bldg Springfield Ill
V-T Drlg Co 711 Hulman Bldg Evansville Ind
Varner-Neill Drlg Co Box 492 Abilene Tex
W H Varner Drlg Co Box 492 Abilene Tex
Veeder Supply & Dev Co Box 201 Cherryvale Kans
Viersen & Cochran Box 280 Okmulgee Okla
Viking Drlg Co 102 W Crockett St San Antonio 5 Tex
John W Voss Drlg Co Inc 1322 Highland Dr McAllen Tex

W

Wade Drlg Co Box 70 Cushing Okla
Wagner & Wyant Drlg Co Inc 414 Petroleum Bldg Amarillo Tex
J H Wagner Drlg Co Box 751 Eldorado Kans
Walters Drlg Co 510 Orpheum Bldg Wichita Kans
Walters Drlg Co Inc 4114 McMillan Dallas 6 Tex
Rusty Walters Drlg Co Box 304 Bakersfield Calif
Ward Drlg Co 106 Oil & Gas Bldg Wichita Falls Tex
Warner & Luttrell Drlg Co 1217 Palm Abilene Tex
Warren Drlg Co 1012 Mayo Bldg Tulsa 3 Okla
Warton Drlg Co Box 2807 Odessa Tex
Carnes W Weaver Drlg Co 326 Gulf Bldg Houston Tex
C B Webster Drlg Co 609 San Jacinto Bldg Houston Tex
Webster Drlg Co 424 S Cheyenne Tulsa Okla
Dick Wegener Drlg Contr 1820 First Natl Bldg Oklahoma City Okla
Art West Drlg Co 205 O'Michael Bldg Odessa Tex
West Central Drlg Co 717 Citizens Bk Bldg Abilene Tex
Western Drlg Co Inc 902 Lubbock Natl Bk Bldg Lubbock Tex
Western Offshore Drlg & Expl Co 3500 Cherry Ave Long Beach Cal
Western Serv Drlg Co Inc Box 1428 Odessa Tex
Wes-Tex Drlg Co Box 2058 Abilene Tex
Chet Whaley Well Serv Co Inc 6006 Milart St Houston 21 Tex
Wheless Drlg Co Box 368 Shreveport La
Wilbanks & Rutter Drlg Co 2200 Scurry St Big Spring Tex
Wilkinson Drlg Co 1121 Union Natl Bldg Wichita Kans
A W Williams Drlg Co Inc 411 Virginia St Mobile Ala
Kidd Williams Drlg Corp 205 Kennedy Bldg Tulsa Okla
Walter W Willis 813 Broadway Mt Vernon Ill
Wilson Drlg Co Inc Box 933 Jackson Miss
C R Winn Drlg Contr Box 331 Salem Ill
Woodson Prod Co 412 Exposition Dallas 26 Tex
Woolf & Magee Inc Box 635 Tyler Tex

Y

S P Yates Drlg Co 311 Carper Bldg Artesia N Mex
Marshall R Young Drlg Co Box 712 Brookhaven Miss

Z

Zapata Off-Shore Co 2218 First City Natl Bk Bldg Houston Tex

Additional U. S. Rotary and Cable Tool Contractors

Drilvo (subs of Drlg & Expl Co Inc) Hague Holland
Great Western Drlg Co Box 1659 Midland Tex
J W Lawrence Box 942 Conrad Mont
McClure Oil Co Box 147 Alma Mich
Riley & Gammon 509 N Railroad St Madisonville Ky
Earl F Wakefield 515 Union Center Bldg Wichita Kans
Travis Ward Drlg Co Box 711 Athens Tex
Wells Drlg Co 5382 Cherry Ave Long Beach Calif

U. S. Contract ROTARY Drilling Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALABAMA						
Mobile County						
Zach Brooks Drlg Co	4	gas	1350	Brwstr N-75	1350	12,000
Jett Drlg Co Inc	104	dsl	1250	Brwstr N-75	1000	12,000
	108	dsl	1250	Brwstr N-75	1000	12,000
Justiss-Mears Oil Co Inc	1	dsl	350	Emsco GB-800	900	13,000
	7	dsl	700	Emsco J-750	1000	11,500
ARIZONA						
Apache County						
D-K Drlg Co	1	gas	675	Natl 50	675	7,500
ARKANSAS						
Columbia County						
E G Bradham	1	LPG-gas	—	Crdwll S	180	6,000
	2	LPG-gas	—	Brwstr N-4	280	7,000
Maritzky & Bibby	2	gas	330	Crdwll	145	3,000
Johnson County						
B M McGraw Drlg Contr	1	gas-gaso	900	Brwstr N-7	900	8,000
Lafayette County						
Hilburn Industries Inc	2	gas	550	Wisn	—	10,000
Kern Drlg Co Inc	2	gas	600	Emsco GB-350	500	7,500
Montgomery Drlg Co	2	gas-btne	415	Brwstr N-55	—	7,500
Logan County						
Parker Drlg Co	5	gas	—	Natl L-50	700	9,000
	30	gas	—	Natl L-50	700	9,000
Viersen & Cochran	10	gas	325	Natl 50	450	8,800
Miller County						
Barnwell Drlg Co Inc	34	dsl	800	Unit U-34	380	7,000
Milton Crow Inc	3	gas	600	Brwstr N-7	400	7,500
Ouachita County						
Crow Drlg & Prod Co	17	dsl	650	Brwstr CR-48T	650	7,500
Crow Greyhound Drlg Co Inc	1	dsl	300	Brwstr N-4	280	5,500
H F Hatcher & Son	2	gas-gaso-btne	250	Crdwll S-350	250	5,500
Saline County						
Walters Drlg Co Inc	3	gas	130	Mayhew	130	1,000
	4	gas	130	Mayhew 1000	130	600/2½"
	5	gas	150	Mayhew 1000	150	600/2½"
	8	gas	220	Mayhew 1000	220	600/2½"
Union County						
Cook Drlg Co	21	gas-btne	475	Wisn Mogul	290	6,000
H F Hatcher & Son	1	gas-gaso-btne	225	Crdwll RL-597	165	4,000
Jackson Oil Co	2	dsl	250	Spencer	200	6000/3½
Mercury Drlg Corp	1	gas	200	Ideco H-20	200	3,500
Trimble Drlg Co Inc	2	dsl	310	Emsco GB-250	310	6,500
CALIFORNIA						
Colusa County						
Brown Drlg Co	9	gas	900	Natl 50-CA	450	8,500
Fresno County						
Barnes Core Drlg Co	D-10	dsl	450	Custom	450	5,500/3"
John S Hagestad Drlg Co	4	dsl	680	Ideco H-525	440	7,500
Haney & Williams Drlg Co	3	gas	1250	Natl 75	1350	10,000
Hayes & Sprague, Inc	2	dsl	1950	Natl 125	1950	16,000
Knight Drlg Co	1	dsl	1020	Unit U-35D	500	8,000
Newton Drlg Co	2	dsl	320	Ideco H-40	—	5,000
	4-40	dsl	320	Emsco GB-250	—	6,000
Glenn County						
B J & M Drlg Co Ltd	2	gas	450	Emsco GA-500	450	7,500
Brown Drlg Co	2	dsl	825	"Oilwell" 66	550	9,500
	3	dsl	825	"Oilwell" 66	550	9,500
Coastal Drlg Co	1	dsl	1500	Emsco J-1250	1920	16,000
Green & Dreblow Drlg Co	1	dsl	600	Wisn Giant	600	7,500
L & F Drlg Co	3	gas-dsl	900	Emsco 450	—	8,000
Kern County						
B J & M Drlg Co Ltd	4	dsl	600	Natl 50	600	8,500
Casey & Montgomery Inc	D	dsl	1800	Natl 110	1800	16,000
	E	gas	1000	Natl 75	1000	10,000
Casner & Bentz	1	gas-btne	445	Emsco GA-250	195	4,500
Coastal Drlg Co	2	dsl	800	Emsco J-750	1320	11,000
	4	gas	1000	Emsco GB-800	1050	12,000
H Davis & R H Thompson Co	1	dsl	300	Emsco G-300	300	6,000
Douglas Drlg Co	1	btne	125	Emsco	125	2,500
	2	gas-btne	600	Emsco GA-250T	250	5,500
Armstrong Fowler Inc	2	dsl	200	Natl T-12	250	3,000
Fowler Drlg Co	5	gas	1200	Emsco GC-500	900	10,500
Green & Dreblow Drlg Co	2	dsl	600	Wisn Giant	600	8,500
John S Hagestad Drlg Co	2	dsl	540	Ideco H30-D	340	4,500
	3	dsl	625	Emsco GB-350	400	7,000
Hylton Drlg Co	1	btne	208	Natl T-12	216	3,500
	2	btne	85	Wisn Sr	85	2,500
	4	dsl	100	Gen Mach	105	3,500
Ivy Drlg Co	1	dsl	185	Hopper IG	185	1,500
	2	btne	185	Hopper GF	185	3,000
K L Kellogg & Sons	25	dsl	1480	Natl 75	1480	9,500
	27	gas	2000	Natl 100	1050	13,000
	28	dsl	1350	Natl 100	1100	13,000
	31	gas	1580	Natl 125	1050	15,000
	32	gas	1400	Natl 75	1050	9,500
L & F Drlg Co	2	dsl	500	Emsco GB-250	—	5,000
Lloyd Drlg Co	1	dsl	264	Emsco GB-160	176	3,500
Myers Drlg Serv	9	dsl	165	Crdwll	165	3,000/3½"
Newton Drlg Co	1	dsl	300	Ideco H-30	—	4,000
Rocky Mountain Drlg Co	10	dsl	1200	Emsco J-1000	1550	15,000
	13	gas	1200	Emsco J-1250	1500	20,000
	14	gas	1200	Emsco J-1250	1500	20,000
Sills Drlg Co	1	dsl	600	Custom	350	5,500/3½"
Rusty Walters Drlg Co	1	dsl	300	Wisn Mogul	300	7,000/4"
Los Angeles County						
Drlg & Prod Co	1	dsl	325	Crdwll	420	6,000
	2	dsl-gas-gaso	325	Crdwll D	432	6,000
Graham & Klassen Drlg Co Inc	3	gas	1500	Natl 75	1200	11,000
Haney & Williams Drlg Co	1	dsl	450	Wisn Gnt Trcr	300	5,500
	5	gas	1750	Wisn Titan	1050	13,000
	6	elec	850	Natl 75	500	10,000
Hayes & Sprague Inc	1	gas	1050	Wisn Titan	1050	13,000
Fred Johnson Drlg Co	1	gas-gaso	1050	Emsco J-1000	1050	12,000
	2	gas-gaso	1750	Emsco J-1000	1050	10,000
	3	gas-gaso	700	Natl 50	700	6,500
Kee & Simpson Drlg Co	1	gas-btne	—	Natl 50	380	6,500
	2	gas-btne	—	Beth 58	420	7,000
K L Kellogg & Sons	18	gas	925	Natl 50	650	7,000
	19	dsl	1200	Natl 75	790	9,500
	35	dsl	1800	Natl 130	1800	18,000
Macrate Prod Co	2	dsl	300	Ideco HD-30	190	3,500
	7	gas	300	Wgnr Mrhse	250	4,000
Rocket Drlg Co	1	gas-btne-prop	555	Emsco G-300	350	4,500
Rocky Mountain Drlg Co	7	gas	1200	Natl 100	1110	15,000
Santa Fe Drlg Co	3	gas	900	Emsco G-500	440	7,500
	23	dsl	330	Ideco H-40	300	6,000
	26	gas	1200	Wisn Titan	900	10,000
	29	elect	1000	Natl 3410-1/2FE	800	15,000
The Sun Drlg Co	2	gas	1400	Natl 125	1250	15,000
	3	elect	750	Natl 110	1100	15,000
	4	elect	1000	Natl 110	1100	15,000
	5	gas	1850	Natl 110	1500	15,000
Terminal Drlg & Prod Co	3	dsl	—	Wisn Mogul	350	5,000
	4	gas	—	Ideco H-40	460	6,000
	5	dsl	—	Ideco H-40	350	5,000
	14	gas	—	Ideco H-25	105	2,000
	17	dsl	—	Wisn Mogul	350	5,000
Wells Drlg Co	2	dsl	325	Hopper Blitz 622	350	5,000
Orange County						
H Davis & R H Thompson Co	2	dsl	300	Emsco GA-250-T	300	6,000
Graham & Klassen Drlg Co Inc	2	gas	1400	Natl 75	1050	10,500
K L Kellogg & Sons	23	gas	2090	Natl 75	790	9,500
Terminal Drlg & Prod Co	2	dsl	—	Natl 50A	700	8,500
San Benito County						
John S Hagestad Drlg Co	1	dsl	570	Emsco GB-350	400	7,000
Petrolex Inc	1	dsl	280	Hopper Blitz	150	5,000/3½"
San Bernardino County						
Santa Rosa Drlg Co	1	prop-gas	155	—	130	2,000
San Joaquin County						
Rusty Walters Drlg Co	1	dsl	300	Cooper D-50	300	6,500/4"
San Mateo County						
Barnes Core Drlg Co	D-11	dsl	225	Custom	225	3,000/3½"
Santa Barbara County						
Casner & Bentz	2	gas-btne	800	Emsco GA-450	550	8,000
Fowler Drlg Co	4	gas	855	Natl T-32	370	5,500
Santa Fe Drlg Co	11	gas	600	Wgnr-Mrhse	220	6,000
Santa Clara County						
Drlg & Expl Co of Delaware Inc	20	gas-gaso	1200	Natl 100	900	13,500
	31	gas-gaso	1500	Natl 130	1200	18,000
Solano County						
B J & M Drlg Co Ltd	1	dsl	600	Unit-35-D	400	7,000
Sonoma County						
Brown Drlg Co	7	"Mighty Mole" dsl	900	Emsco GC-350	600	9,500
Ventura County						
B J & M Drlg Co Ltd	3	gas	450	Natl 50	775	8,500
Casey & Montgomery Inc	B	gas	1300	Natl 75	1300	10,000
	C	dsl	1000	Natl 50	700	8,500

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Creative Engineering

From the earliest beginnings of man's search for oil to the modern ways of today, creative engineering has been the mainspring behind man's untiring efforts. LEE C. MOORE, with fifty years of experience in the building of oil industry structures, has built a worldwide reputation upon creative engineering — continually reflected in the structures we build today and in those we are designing for tomorrow.

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FOREIGN LICENSED MFR.: OIL WELL ENGINEERING CO., LTD., CHEADLE HEATH, STOCKPORT, ENGLAND

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Drlg & Expl Co of Delaware Inc	28	gas-gaso	800	Natl 50A	750	10,000
	29	gas-gaso	1500	Natl 34-10	1200	18,000
Graham & Klasson Drlg Co Inc	4	gas	1400	Wisn Titan	1050	10,500
Haney & Williams Drlg Co	2	gas	1050	Natl 50	700	8,000
K L Kellogg & Sons	7	gas	2240	Natl 100	1050	13,000
	29	gas	1370	Natl 75	700	9,500
	34	gas	2475	Natl 125	2475	16,000
	36	gas	2475	Natl 125	2475	16,000
Rocky Mountain Drlg Co	1	gas	1200	Natl 75	900	11,000
	2	gas	1200	Natl 75	900	11,000
	3	gas	1200	Natl 100	900	14,000
	4	gas-dsl	1400	"Oilwell" 96	1750	20,000
	5	gas	1480	"Oilwell" 96	1850	20,000
	6	gas	1200	Emsco J-1000	1550	15,000
	8	gas	1400	Natl 125	1750	20,000
	9	gas	1200	Natl 125	1500	20,000
	12	gas	1480	Natl 125	1850	20,000
	15	gas	1200	Emsco J-750	900	11,000
Santa Fe Drlg Co	9	gas	1050	Wisn Titan	900	10,000
	25	gas	1200	Natl 55	900	10,000
	28	gas	1200	Natl 80-B	1350	12,000
The Sun Drlg Co	1	dsl	950	Natl 110	1425	15,000
Terminal Drlg & Prod Co	6	dsl	—	Emsco GC-500	440	7,000
	18	dsl	—	Ideco H-525	540	8000
United Drlg Co	1	gas	380	Emsco EDA	450	6,000
COLORADO						
Adams County						
Taylor Expl Co Inc	6	btne	—	Failing	—	1,200
Bent County						
Holm Drlg Co	4	dsl	560	Wisn Giant	300	5,500
Service Drlg Co	8	LPG	300	Unit U-34	320	4,500
Dolores County						
Moran Bros Inc	8	gas	700	Wisn Giant	750	10,000
Grand County						
B F Allison Drlg Co	2	gas-btne	675	Unit U-15	675	8,500
La Plata County						
Anschutz Oil Co Inc	4	gas	800	Wisn Giant	700	8,500
Exploration Drlg Co	10	gas	505	Unit U-15	400	8,000
Great Western Drlg Co	20	dsl	265	Frnks Sal 1600	600	5,500
Nichols Drlg Co	10	gas-btne	450	Wisn Giant	450	7,500
Urice Drlg Co	1	gas-btne	700	Emsco GA-500	700	8,500
Las Animas County						
Earl F Wakefield	2	dsl	640	Wisn Gnt Rdair	640	8,500
Logan County						
Ashby Drlg Co Ltd	2	dsl	300	Natl T-20	300	8,000/3½"
Lohmann-Johnson Drlg Co Inc	1	dsl	300	Natl 50	480	5,500
Mesa County						
Carmack Drlg Co	5	gas	400	Natl T-32	320	6,000
Taylor Expl Co Inc	1	btne	—	Mayhew	125	3,000
Moffat County						
Camay Drlg Co Rocky Mt Div	1	gas	775	Unit U-15	600	8,500
Carmack Drlg Co	1	dsl	680	Natl 50-A	450	8,000
Nye & Snell Drlg Co	4	dsl	320	Unit U-15	320	6,000
Rowan Drlg Co Inc	24	gas-btne	504	Natl 50	1077	8,500
Montezuma County						
Don Johnston Drlg Co	3	gas-btne	650	Natl 50	650	7,500
Great Western Drlg Co	23	dsl	500	Unit U-15	800	7,500
Nye & Snell Drlg Co	1	gas	550	"Oilwell" 66	550	6,000
Morgan County						
Ashby Drlg Co Ltd	1	dsl	300	Natl T-20	300	8,000/3½"
Exeter Drlg Co	2	btne	320	Emsco GA-250	250	6,000/4"
Garvey Drlg Co	17	dsl	300	Wisn Roadair	450	7,000/3½"
Herndon Drlg Co	3	gas	600	Natl 50	750	8,000
	8	gas	600	Natl 50-A	750	10,500
Rio Blanco County						
Bauman Drlg Co	1	dsl	—	Wisn Atlas	600	10,000
A O Bullock Drlg Co	3	gas	370	Beth Twister	—	7,500
Carpenter-Trant Drlg Co	1	btne	185	Crdwll RL	185	3,000
Delta Drlg Co	25	gas-btne	1520	Emsco J-1250	1250	15,000
Kerr-McGee Oil Ind Inc	42	gas	970	Natl 75	818	11,500
Will I Lewis Drlg Co	6	dsl	1450	Unit U-20	1450	14,000
George Noland Drlg Co Inc	8	gas-btne	—	Emsco GA-500	730	8,500
Washington County						
Garvey Drlg Co	12	dsl	300	Wisn Giant	320	6,000/3½"
Weld County						
B F Allison Drlg Co	1	gas-btne	450	Natl T-32	400	5,500
	5	gas-btne	450	Frnks 137	390	5,500
Baird & Pfeifer Drlg Co	2	gas	650	Unit U-15	—	7,500
FLORIDA						
Glades County						
Dorris Ballew Inc	3	dsl	760	Wisn Titan	1900	15,000
Walton County						
Gulf Coast Drlg Co Inc	1	gas-dsl	1200	Beth MC-950	1200	15,000
ILLINOIS						
Christian County						
Henson Drlg Co	6	dsl	250	Unit U-24	150	2,000
LaMac Oil Co	1	dsl	—	Wisn Giant	600	4,700
U & E Drlg Co	—	dsl	400	Crdwll S	200	3,500
Clark County						
Don Slape Drlg Co	3	dsl	260	"Oilwell" 64-B	230	5,500
V S & S Drlg Co	2	dsl	—	Wisn	—	2,400
Clay County						
Claypool Drlg Co	2	btne	300	Natl T-12	185	4,500
Paco Petroleum Corp	3	dsl	320	Unit U-35	320	7,000
Don Slape Drlg Co	4	dsl	300	Lewstr N-4	245	4,500
Clinton County						
Claypool Drlg Co	1	btne	300	Natl T-20	185	4,500
Conrey Drlg Co	1	gas	140	Wisn Super	140	2,000/3½"
M Mazzarino	—	gas-gaso	200	Frnks 2000	200	2,500
U & E Drlg Co	—	dsl	500	Frnks 4500	400	5,000
Crawford County						
W L Dillier	3	gas	—	Failing 2500	130	2,000
Hoagland Drlg Co Inc	1	btne	145	Frnks 2000	—	2,000/2⅛"
Edwards County						
General Geophysical Co	27	dsl	—	—	400	4,500
Paco Petroleum Corp	2	btne	200	Wisn Mogul	165	4,000
Fayette County						
W L Dillier	2	gas	—	Failing 2500	130	2,000
C R Winn Drlg Contr	1	dsl	135	Wisn Super	135	3,000/4½"
Gallatin County						
Kendall-Davis Drlg Co Inc	1	dsl	300	Wisn Mogul	300	4,000
Lohmann-Johnson Drlg Co Inc	7	gas	300	Crdwll S	400	4,500
T & H Corp	1	dsl	225	Crdwll L	225	3,500
V S & S Drlg Co	4	dsl	—	Beth	—	4,200
Hamilton County						
C E Brehn	2	dsl	240	Brwstr N-45	—	7,000
Pep Drlg Co	2	dsl	330	Ideco H-35	340	6,000
Walter W Willis	1	dsl	—	Beth S-45E	—	4,500
	2	dsl	278	Natl T-12	237	4,500
Jasper County						
D B Lesh Drlg Co	3	dsl	200	Natl T-20	200	4,000
J W Rudy	1	dsl	150	Natl T-20	185	5,000
	50	dsl	250	Natl 50	214	6,000
Don Slape Drlg Co	1	dsl	260	"Oilwell" 64-A	230	5,000
Jefferson County						
E F Moran Inc	2	btne	300	Natl T-12	300	4,500
Kankakee County						
Moran Bros Inc	11	dsl	300	Wisn Giant	350	5,000
	14	dsl	275	Natl T-12	300	4,500
La Salle County						
D B Lesh Drlg Co	1	dsl	200	Natl T-20	200	4,000
Lawrence County						
W L Dillier	1	gas	—	Natl T-12	212	3,000
Marion County						
Conrey Drlg Co	2	dsl	175	Wisn Super	175	2,500/3½"
Perrine & Perrine Drlg Contr	1	btne	—	Crdwll S	185	6,000
Graham Powell	1	dsl	—	Natl 50	—	6,000
	2	dsl	—	Natl T-12	—	3,200
C R Winn Drlg Contr	2	dsl	225	Crdwll L	225	4,000/3½"
Mercer County						
Don Slape Drlg Co	5	btne	360	Natl T-12	260	4,500
Richland County						
Calvert Drlg Inc	11	dsl	260	Natl T-32	190	5,000
Woody Jones Drlg Co	1	dsl	240	Unit U-34	230	4,500
Don Slape Drlg Co	2	dsl	240	Unit U-34	230	4,500
St Clair County						
Henry Gwaltney Drlg Co	3	gas	100	—	100	1,500
Saline County						
C E Brehn	1	dsl	240	Brwstr N-45	—	7,000
Calvert Drlg Inc	8	dsl	260	Ideco H-30	190	4,500
Shelby County						
Troop Drlg Co	1	gas-gaso	—	Natl T-20	200	4,500
Wabash County						
Houchins Drlg Co	1	gas	185	Natl T-12	185	4,500
Olds Oil & Chem Corp	1	btne	—	—	200	3,500
Washington County						
Ted Lindsay	31	dsl	220	Crdwll S	160	4,500
Wayne County						
Calvert Drlg Inc	12	dsl	260	Ideco H-30	260	4,500
D B Lesh Drlg Co	4	gas	450	Natl 50	450	7,000
Ted Lindsay	2	dsl	220	Natl T-16	220	5,000
The Noah Petroleum Co	1	dsl	300	Brwstr N-4	300	5,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
White County						
Calvert Drlg Inc	16	dsl	260	Ideco H-35	190	5,000
Eastern Drlg Inc	1	dsl	266	Natl T-20	—	5,000
Harris Drlg Co	2	btne	276	Natl 40	172	4,000
	3	dsl	285	Natl 50	285	8,500
Herndon Drlg Co	7	gas	409	Natl T-32	559	4,500
	9	gas	240	Natl T-25	390	4,000
Ted Lindsay	3	dsl	160	Ideco H-30	160	4,000
Gene Miller Inc	5	dsl	300	Brwstr N-4	—	4,500
E F Moran Inc	4	btne	300	Brwstr N-3	300	3,500/3½"
Paco Petroleum Corp	1	dsl	320	Natl T-32	320	6,000
Pep Drlg Co	1	dsl	330	Beth Breeze	340	5,000
INDIANA						
Gibson County						
Harris Drlg Co	1	btne	195	Crdwll S	172	4,000
Herndon Drlg Co	5	gas	375	Brwstr N-4	375	4,500
Lohmann-Johnson Drlg Co Inc	6	btne	300	Crdwll S	440	4,500
E F Moran Inc	3	btne	300	Crdwll S	300	4,000
Pike County						
Henry Gwaltney Drlg Co	1	dsl	200	Natl T-12	165	3,000
Olds Oil & Chem Corp	2	btne	—	—	85	1,500
Posey County						
Anderson Drlg Contr	1	dsl	150	Crdwll 67-L	150	4,000
Kendall-Davis Drlg Co Inc	2	dsl	300	Crdwll S	300	4,000
E F Moran Inc	1	btne	300	Brwstr N-4	600	6,000
Sullivan County						
Hupp & Hume	1	dsl	325	Natl 40	350	4,500
IOWA						
Dallas County						
Kirby Oil Ind	—	dsl	400	Brwstr N-4	400	4,500
	—	dsl	300	Unit U-34	275	4,500
	—	gas-gaso	400	Mayhew 3000	145	3,000
KANSAS						
Barber County						
Beardmore Drlg Co	2	dsl	300	Emsco 300	320	4,000
Garvey Drlg Co	3	dsl	175	Unit U-15	296	5,000
	5	dsl	175	Unit U-15	296	5,000
	15	dsl	175	Wlsn Giant	296	5,000
Patton Drlg Co Inc	1	gas	—	Natl 50	450	6,500
	2	dsl	—	Natl 50	350	5,500
Prime Drlg Co	5	dsl	300	Natl T-20	300	5,000
Barton County						
Bennett & Roberts Drlg Co	1	dsl	250	Emsco 250	250	5,000
Quaker Drlg Co Inc	1	dsl	185	Wilson	185	3,600
Shelley-Miller Drlg Co	1	dsl	—	Wlsn	—	5,500
Wilkinson Drlg Inc	2	dsl	300	Unit U-15	335	6,000
Butler County						
Criswell Drlg Co	1	dsl	300	Unit U-34	300	4,500
Comanche County						
Capitt Drlg Inc	3	dsl	525	Beth C-50	500	8,500
Cowley County						
Capitt Drlg Inc	5	gas-btne	250	Beth FC-200	400	4,500
Earl F Wakefield	1	dsl	440	Wlsn Mogul Rdair	440	5,000
Dickinson County						
Greenland Drlg Co	1	dsl	190	Emsco 160	190	4,500
Donald T Ingling	4	dsl	225	Brwstr N-4	225	5,500
Edwards County						
Gabbert-Jones Drlg Co	3	gas	380	Emsco 300	380	5,000
Elk County						
R L Horn & Sons Drlg Co	2	dsl	185	Frnks Sr Clpr	185	4,000
Ellis County						
Buick Drlg Inc	2	dsl	300	Wilson	—	4,500
Garvey Drlg Co	11	dsl	175	Wlsn Giant	296	5,000
Isern Drlg Co	1	dsl	450	Unit U-15	450	7,000
Murfin Drlg Co	2	dsl	200	Natl T-20	260	5,000
Prime Drlg Co	3	dsl	275	Unit U-34	285	4,500
Quaker Drlg Co Inc	2	dsl	185	Unit	350	4,500
Shields Drlg Co Inc	3	dsl	400	Wlsn Gnt	400	6,000
Gove County						
Murfin Drlg Co	3	dsl	260	Natl T-20	260	5,000
Graham County						
Empire Drlg Co (Kans)	21	dsl	300	Natl T-32	300	5,000
Herndon Drlg Co	10	gas	409	"Oilwell" 64-A	559	4,500
K & E Drlg Inc	2	dsl	285	Natl T-20	—	5,000
Murfin Drlg Co	4	dsl	260	Wlsn Rdair	450	7,000
Greenwood County						
Greenwood Pet Mgmt Inc	1	dsl	—	Frnks 5000	—	—
Hamilton County						
Graham-Michaelis Drlg Co	3	dsl	300	Crdwll S	175	5,000
Harper County						
Herndon Drlg Co	6	gas	409	Natl T-32	559	6,000
Dale Mount Drlg Inc	114	gas	570	Crdwll	570	7,000
Walters Drlg Co	1	gas-btne	—	Natl 50	500	5,500
Haskell County						
D & M Drlg Co Inc	3	dsl	600	Unit U-15	600	7,500
R W Rine Drlg Co	1	gas-btne	620	Unit U-15	600	7,500
Kingman County						
Thos H Allan	1	btne	175	Crdwll K	250	4,000
D & M Drlg Co Inc	2	gas-btne	225	Brwstr N-4	280	5,000
Gabbert-Jones Drlg Co	1	gas	380	Emsco 300	380	5,000
Herndon Drlg Co	1	gas	409	"Oilwell" 64-B	559	6,000
Transit Corp	3	dsl	280	Emsco	—	4,500
Kiowa County						
Falcon Seaboard Drlg Co	20	gas-btne	425	Unit U-15	425	8,500
Marion County						
Lewis Drlg Co	1	dsl	260	Crdwll	300	6,000
Wilkinson Drlg Inc	1	dsl	300	Unit U-34	335	4,000
McPherson County						
Capitt Drlg Inc	2	dsl	300	Beth S-45	285	5,000
Rupp-Ferguson Oil Co	1	dsl	350	Ideco H-35	350	5,000
Veeder Supply & Dev Co	E	dsl	270	Frnks 658	270	3,500
Meade County						
D & M Drlg Co Inc	1	gas-btne	550	Natl 50	550	7,500
Lewis Drlg Co	4	dsl	450	Crdwll	450	6,000
Unit Drlg Co	2	gas-btne	900	Unit U-15	900	8,500
Morton County						
Musgrove Petroleum Corp	3	dsl	440	Natl 80	—	5,500
Ness County						
Capitt Drlg Inc	4	gas-btne	300	Beth MC-250	500	5,000
Phillips County						
Lewis Drlg Co	3	dsl	260	Crdwll	260	5,500
Pratt County						
Graham-Michaelis Drlg Co	6	dsl	275	Beth Breeze	175	4,000
Powell Drlg Co	1	dsl	—	Emsco GB-350	350	6,500
Reno County						
Walters Drlg Co Inc	7	gas	175	Mayhew 1000	175	900/2¼"
Rooks County						
Garvey Drlg Co	14	dsl	175	Wlsn Giant	296	5,000
Transit Corp	2	dsl	280	Emsco	—	4,500
	4	dsl	280	Emsco	212	4,500
Veeder Supply & Dev Co	D	dsl	280	Natl T-25	300	4,500
Rush County						
Ari-Kan Drlg Co	1	dsl	165	Natl T-12	150	4,500
Russell County						
Anschutz Oil Co Inc	1	dsl	300	Wlsn Giant	280	5,000
Bennett & Roberts Drlg Inc	3	dsl	250	Emsco 250	250	5,000
Lohmann-Johnson Drlg Co Inc	3	btne	300	Natl 50	450	5,500
Mast Drlg Inc	2	dsl	185	Natl T-32	250	5,500
Shields Drlg Co Inc	2	dsl	300	Beth C-50	300	6,000
Sedgewick County						
Garvey Drlg Co	10	dsl	175	Wlsn Giant	296	5,000
Seward County						
Bennett & Roberts Drlg Co	2	dsl	250	Emsco 250	250	6,000/3½"
Graham-Michaelis Drlg Co	1	dsl	275	Beth Twister	500	6,500
Stafford County						
Garvey Drlg Co	8	dsl	175	Wlsn Giant	296	5,000
K & E Drlg Inc	1	dsl	285	"Oilwell" T-52	—	6,000
Musgrove Petroleum Corp	8	dsl	230	Natl 50	—	5,000
Prime Drlg Co	2	dsl	300	Beth S-45	300	5,000
Reserve Drlg Co Inc (Kans)	3	dsl	320	Natl T-32	320	5,500
Sumner County						
Beardmore Drlg Co	1	dsl	300	Natl 50	450	6,000
Falcon Seaboard Drlg Co	27	gas-btne	185	Unit U-34	210	5,000
KENTUCKY						
Estill County						
Overby Drlg Co Inc	3	btne	250	Mayhew 2000	250	2,000
Henderson County						
Big Seven Drlg Co	1	dsl	300	Emsco GB	300	4,500
Temple Drlg Co Inc	2	dsl	300	Crdwll S	440	4,500
Hopkins County						
Stouder Drlg Co	1	LPG	200	Natl 40	160	4,500
Muhlenberg County						
Hupp & Hume	2	dsl	165	Natl 40	300	3,000
Stouder Drlg Co	2	LPG	200	Natl T-12	160	4,000
Ohio County						
Henry Gwaltney Drlg Co	2	gas-prop	200	Crdwll	165	3,000
Webster County						
V-T Drlg Co	1	dsl	220	Crdwll H	160	4,000
LOUISIANA						
Acadia Parish						
Pernie Bailey	1	gas	650	TIW CT-5	—	9,000
Drlg & Expl Co of Del Inc	36	stm	1400	Natl 34-8	—	15,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Falcon Seaboard Drlg Co	3	Stm	1000+	Alco BIW 12	1200+	17,000
	11	stm	1000+	Alco BIW 12	1200+	17,000
Gilger Drlg Co	5	stm	1000	Emsco	1000+	14,000
Glasscock-Wilson Inc	8	gas	1600	Natl 110	1200	15,000
	10	gas	1050	Natl 55	800	10,500
M M Lindsey Drlg Co	2	gas	290	Natl T-32	—	6,000
Mac Drlg Co	3	stm	600	Natl 23-9-FE	1000+	20,000
Owen Drlg Co	7	stm	1000+	Emsco	—	16,000
	9	stm	740	Ideco Big Gnt	540	16,000
Sunnyland Contr Co Inc	3	stm	—	Emsco ECB	724	16,000
	9	dsl	—	Crdwll D	450	8,000
Allen Parish						
Glasscock-Wilson Inc	11	gas	1050	Natl 55	800	10,500
Inca Drlg Co	2	dsl	1000	Beth M-58	1000	10,500
Penrod Drlg Co	26	gas	—	—	730	9,000
Assumption Parish						
Delta Drlg Co	11	stm	1000	Emsco UBLS-54	1690	15,000
Dixie Drlg Co Inc	2	dsl	1350	Beth	2000	17,500
Gracey-Hellums Corp	Bge 2	stm	1200	Natl 23-9FE	1200	15,000
Grey Wolf Drlg Co	1	gas-btne	945	Emsco GB-800	—	12,500
W P Taylor Drlg Co	1	gas	—	Emsco	1000	13,000
Beauregard Parish						
A W Eggleston Inc	2	gas-btne	500	Ideco M-10000	627	9,500
Carnes W Weaver Drlg Co	3	gas-btne	700	"Oilwell"	—	10,500
Bienville Parish						
Butler-Johnson Inc	1	gas-btne	650	Brwstr N-75	1005	10,000
Nowery Drlg Co Inc	3	dsl	300	Natl T-32	3000	6,500
Woolf & Magee Inc	12	gas-btne	275	Beth S-45	275	10,000/2⅞
Bossier Parish						
B-M Drlg Co Inc	2	gas	685	Emsco GB-350	500	8,000
Cook Drlg Co	18	gas-btne	670	Wisn Atlas	650	10,000
Kern Drlg Co Inc	3	dsl	260	Emsco GB-250	260	6,000
Ruhl Drlg Co Inc	1	—	475	Brwstr N-7	625	8,500
Wheless Drlg Co	Bge 10	gas-btne	900	Brwstr N-7	700	9,500
Caddo Parish						
W C Allen Drlg Co	1	gas-btne	145	Wisn Super	78	3,000/3½"
	2	gas-btne	145	Wisn Super	78	3,0003½"
Barnwell Drlg Co Inc	4	gas	500	Wisn Giant	185	5,000
Carter-Jones Drlg Co	10	gas-btne	—	—	500	7,000
Milton Crow Inc	4	gas	900	Brwstr N-75	600	10,000
B F Edington Drlg Co Inc	102	gas-gaso	120	Failing	180	1,500/2⅛"
F E Hargraves & Sons Drlg Co	2	btne	185	Brwstr W-50	185	2,800/3½"
	3	btne	185	Brwstr W-50	185	2,800/3½"
Kendrick Bros	2	gas-btne	185	Brwstr N-4	185	5,000
Kern Drlg Co Inc	1	dsl	260	Emsco GA-250	260	5,000
Nowery Drlg Co Inc	2	dsl	6000	Unit U-15	600	8,000
Pyburn Drlg Co	1	dsl	500	Ideco M-750	750	9,000
C M Roberson Drlg Co	1	gas-btne	400	Brwstr N-45	400	7,300
Tex-Mex Drlg Co	11	stm	—	—	1000+	12,000
Woolf & Magee Inc	7	gas-btne	800	Beth MC-450	800	11,000
	8	gas-btne	1300	Beth Tornado	1300	15,000
Calcasieu Parish						
Brownie Drlg Co	1	gas	430	Unit U-34	190	3,500
	2	dsl	148	Wisn Spr III	148	8,000/2½"
Circle Drlg Co Inc	3	gas-elec	1200	Ideco Big Gnt	2100	15,000
Delta Drlg Co	21	gas-btne	800	Natl 75	650	9,500
Gilger Drlg Co	1	gas-btne	1450	Natl	1450	13,000
	3	stm	1000	Emsco	1000+	13,000
Inca Drlg Co	5	gas	1300	Natl 80-B	1300	13,500
Mac Drlg Co	11	stm	800+	Natl 23-9F-ED	1000+	20,000
Owen Drlg Co	1	stm	540	Ideco Big Gnt	—	15,000
	3	gas	900	Ideco M-1000	—	12,500
Penrod Drlg Co	23	dsl	—	—	730	9,000
Prince Marine Drlg & Exp Co	4	gas	1600	Emsco J-1100	1400+	15,000
Cameron Parish						
Circle Drlg Co Inc	5	gas-btne	1200	Brwstr N-12	1440	15,000
Delta Drlg Co	20	gas-btne	1520	Emsco J-1250	1250	15,000
Falcon Seaboard Drlg Co	1	stm	1200+	Ideco Bg Gnt	2000+	20,000
Glasscock-Wilson Inc	12	gas	1300	Natl 110	1200	15,000
Win Hawkins Drlg Co	1	stm	—	Alco BIW 14	—	15,000
Kelly Drlg Co Inc	1	stm	600	Ideco Jr Gnt	1200	15,000
Mac Drlg Co	10	gas-btne	1000	Natl 130	1300	20,000
Penrod Drlg Co	4	gas-btne	—	—	1425	15,000
	Bge 47	dsl-elec	1250	Emsco EDA	1250	20,000
C B Webster Drlg Co	6	stm	1100	Emsco ECA-10½	1200+	15,000
Wheless Drlg Co	Bge 12	gas-btne	1200	Natl 80	800	12,000
Catahoula Parish						
Fortenbery Drlg Co Inc	4	dsl	500	Ideco H-30	275	7,000
Justiss-Mears Oil Co Inc	6	dsl	250	Emsco G-250	325	7,000/4"
Scooter's Drlg Serv	2	dsl	300	Brwstr N-4	300	4,500
	3	dsl	600	Brwstr N-55	600	6,000
Claiborne Parish						
Delta Drlg Co	17	gas-btne	1020	Emsco J-1100	1300	15,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Drlg & Expl Co of Del Inc	32	stm	1400	Emsco ECA	—	15,000
B F Edington Drlg Co Inc	103	gas-gaso	150	Hacker	200	2,000/2⅛"
Johnson Drlg & Serv Co	1	dsl	200	Beth-Breeze	200	4,500
Maritzky & Bibby	1	gas	330	Brwstr	185	5,000
Wheless Drlg Co	3	gas-btne	600	Emsco GB-350	600	7,500
	5	stm	900	Emsco UBLS-54	1000+	11,000
	13	gas-btne	700	Emsco J-750	750	10,500
Woolf & Magee Inc	5	gas-btne	800	Beth MC-450	800	11,000
Concordia Parish						
Dorris Ballew Inc	6	dsl	380	Unit U-15	600	7,500
Crow Drlg & Prod Co	19	dsl	325	Brwstr C-5	325	7,000/3½"
Jett Drlg Co Inc	105	dsl	600	Natl T-32	500	8,000
De Soto Parish						
Barnwell Drlg Co Inc	7	dsl	600	Brwstr N-75	600	10,000
Wheless Drlg Co	1	gas-btne	600	Brwstr N-45	600	7,500
Franklin Parish						
Johnson Drlg Co	1	dsl	300	Wisn Mogul	275	7,500/3½"
Thrasher Drlg Co Inc	1	gas-btne	350	Unit U-15	600	8,500
Iberia Parish						
Wheless Drlg Co	Bge 6	gas-btne	1000	Wisn Titan	1000	12,000
Iberville Parish						
Glasscock-Wilson Inc	9	gas	1200	Natl 80-B	800	12 500
Hawkins-Wilkins Prod Co	1	stm	—	Natl 3410FE	—	15,000
Jefferson Parish						
Brewster-Bartle Drlg Co Inc	9	dsl	—	"Oilwell" 96	1500	16,000
Cron & Gracey Corp	4	dsl	1450	"Oilwell" 96	1290	15,000
Buster Gardner Drlg Co Inc	1	dsl	—	Beth M-58	—	9,500
C G Glasscock Drlg Co	3	dsl	1500	Emsco J-1250	—	17,000
Prince Marine Drlg & Exp Co	1	dsl	1500	"Oilwell" 96	1500	15,000
Rowan Drlg Co Inc	Bge 6	dsl-elec	1200	Emsco ED	2800	18,000
	30	dsl	1455	Emsco A-1500	1455	20,000
Jefferson Davis Parish						
Bullard Drlg Co Inc	1	stm	1000+	Natl 34-10 FE	1000+	16,000
Clegg & Hunt	1	stm	—	Emsco 10	—	15,000
Steen Drlg Co	1	stm	—	Emsco ECB	—	17,000
	2	stm	—	Emsco ECA	—	17,000
	3	btne-gas	1000	Emsco J-750	1125	11,000
C B Webster Drlg Co	7	stm	1600	Emsco ECA-10½	1200+	15,000
	8	stm	1600	Natl FE-34-10	1200+	15,000
Wheless Drlg Co	4	stm	1000+	Emsco UBLS-54	1000+	12,000
Lafayette Parish						
Circle Drlg Co Inc	2	gas-btne	800	Brwstr N-75	900	11,000
Crawford Drlg Co	1	dsl	695	Brwstr N-7	500	9,000
Falcon Seaboard Drlg Co	2	stm	1200+	Ideco Bg Gnt	2000+	20,000
	29	stm	1200+	Natl 3410 FE	2000+	20,000
Owen Drlg Co	4	stm	1000+	Emsco UBLS-54	—	14,000
Penrod Drlg Co	17	dsl	—	—	1464	14,000
Rowan Drlg Co Inc	8	gas-btne	1920	Natl 125	1920	18,000
C B Webster Drlg Co	3	gas	900	Emsco J-1250	1300	15,000
Lafourche Parish						
B B M Drlg Co	7	stm	—	Emsco EC-54	—	18,000
Brewster-Bartle Drlg Co Inc	6	dsl	—	"Oilwell" 96	1500	—
Bullard Drlg Co Inc	3	stm	1000+	Ideco Big Gnt	1000+	16,000
Clegg & Hunt	4	stm	—	Ideco Big Gnt	—	15,000
	Bge 11	dsl-elec	2600	Ideco 2500	1900	23,000
Crawford Drlg Co	2	stm	—	Emsco ECA	500	15,000
Delta Drlg Co	37	dsl	900	Beth MC-950	1400	15,000
	38	stm	530	Natl 239-S	1135	12,000
Dixie Drlg Co Inc	Bge 4	dsl	1350	Beth	1500	17,500
Doc Drlg Corp	Bge DAN	dsl	1500	Beth 1013	1500	18,000
Blackie Drlg Co Inc Neva-Andre Drlg Corp	Bge DOC	dsl	1500	Beth Tornado	1500	15,000
C G Glasscock Drlg Co	6	dsl	1660	Natl 110	—	16,000
Gracey-Hellums Corp	Bge 1	stm	1000	Natl 34-10FE	1200	15,000
Win Hawkins Drlg Co	4	stm	—	Natl 3410FE	—	15,000
Howell & Howell	3	gas	—	Emsco	696	15,000
	7	stm	—	Emsco	600	15,500
	8	stm	—	Alco BIW DNT12	500	17,250
Marine Drlg Inc	1	stm	1800	Emsco ECB	1000+	15,000
	3	stm	1800	Emsco EDA	1000+	15,000
	5	stm	1800	Emsco UBL54	1000+	15,000
Rowan Drlg Co Inc	Bge 3	dsl-elec	2150	Emsco EDA	3455	20,000
Stewart & Gouger Drlg Co	Bge 1	pwr	—	Natl 130	1800	20,000
Wheless Drlg Co	Bge 11	gas-btne	1200	Emsco J-1250	1250	13,500
Lake Arthur Parish						
Harry L Edwards Drlg Co	5	stm	1000+	Natl 23-10½ FE	1000+	16,000
	6	stm	1000+	Natl 23-9S	1000+	15,000
	7	stm	1000+	Alco BIW 12	1000+	15,000
La Salle Parish						
Justiss-Mears Oil Co Inc	10	dsl	250	Emsco G-250	325	10,000/2⅛
Mercury Drlg Corp	2	gas	200	Wisn Mogul	200	4,000

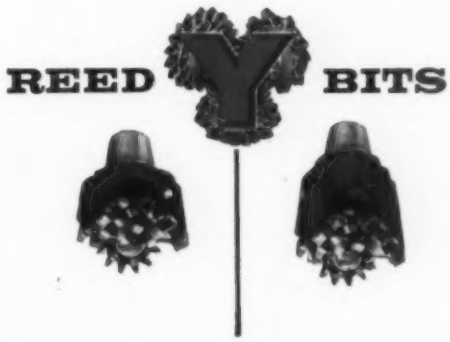
Here comes a good bit... and here's why

Reed Three Cone "Y" Bits are the latest developments in Reed's thirty-seven year history of designing and producing rock bits. The Reed "Y" Bit that is making hole for you today is the result of hundreds of thousands of man hours of research, engineering and technical effort spent by Reed Research and Engineering.

Reed research facilities are located in two large buildings at the Houston plant. They include complete metallurgical and chemical laboratories, mechanical testing apparatus, experimental heat treating facilities and an experimental machine shop. Laboratory drilling rigs that can apply loads of 100,000 lbs., at rotating speeds up to 500 rpm, with pump pressures to 5,000 psi, test full size bits on rock samples from all over the world.

Metallurgists, chemists, designers, engineers work as a team to develop a product that is produced to precise standards by skilled technicians in Reed's manufacturing plant. The compound benefit of *know-how* in design, development and manufacturing is a rock bit that is uniform in quality, bit after bit after bit.

Proved in the field for four years, the Reed "Y" Bit is the bit that will *dig*. You can't run a better bit.



Reed Roller Bit Company

Houston 1, Texas

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Lincoln Parish						
Delta Drlg Co	8	stm	750	Ideco Supr-Duty	1200	12,000
McAlester Fuel Co	—	btne-gas	—	Emsco GC-5000	820	11,000
Wheless Drlg Co	2	gas-btne	600	Wisn Atlas	700	8,500
Ouachita Parish						
Cook Drlg Co	10	gas-btne	900	Wisn Titan	975	12,500
	17	gas-btne	670	Wisn Atlas	650	10,000
Plaquemines Parish						
Brewster-Bartle Drlg Co Inc	2	dsl	—	"Oilwell" 96	1500	16,000
	5	dsl	—	"Oilwell" 96	1500	16,000
	12	dsl	—	"Oilwell" 96	1500	16,000
Clinch Drlg Co	Bge 1	dsl	—	Emsco GA-350	426	8,500
Cron & Gracey Corp	2	stm	—	Natl 23-9-FEC	—	15,000
Delta Drlg Co	5	gas-btne	900	Natl 100	800	12,000
B L McFarland Drlg Corp	Bge 1	dsl	700	Brwstr N-75	—	12,000
Penrod Drlg Co	Bge 41	dsl	—	—	1000	12,000
	Bge 42	dsl	—	Brwstr N-12A	—	18,000
	Bge 44	dsl-elec	—	—	1400	18,000
Prince Marine Drlg & Exp Co	2	dsl	1850	"Oilwell" 96	1500	16,000
Producers Drlg Co Inc	1	dsl	2000	Unit U-1220	2200	20,000/5"
Rowan Drlg Co Inc	Bge 1	dsl-elec	1600	Emsco ECA	2475	18,000
	Bge 21	dsl-elec	1000	Emsco ECA	1920	12,000
	Bge 26	dsl	1325	Natl 100	1545	14,000
Southeastern Drlg Corp	21-Bge 7	dsl	1200	"Oilwell" 96	1600	18,000
C B Webster Drlg Co	Bge 9	dsl	1850	Emsco J-1400	2200	16,000
Rapides Parish						
Ace Drlg Co	2	gas	680	Emsco G-500	500	9,000
Red River Parish						
Gary Drlg Co	1	btne	90	—	90	2,000
	2	btne	145	—	200	4,000
Scooter's Drlg Serv	4	dsl	300	Wisn Giant	300	4,500
Richland Parish						
Big Chief Drlg Co	29	gas	1875	Emsco 1250	1815	16,000
Justiss-Mears Oil Co Inc	8	gas	650	Emsco GA-500	560	11,000
Montgomery Drlg Co	3	gas-btne	225	Crdwll S	200	5,000
St Bernard Parish						
Wm Hawkins Drlg Co	5	dsl	200	Ideco PR1050	900	15,000
Penrod Drlg Co	Bge 45	dsl	—	—	1500	20,000
St Charles Parish						
Delta Drlg Co	32	stm	1200	Ideco Big Gnt	1690	15,000
A W Eggleston Inc	3	dsl	900	Ideco PR-1050	900	14,000
Marine Drlg Inc	4	dsl-elec	3000	Emsco EDA	1600	20,000+
Rowan Drlg Co Inc	Bge 14	dsl-elec	1600	Emsco ECA	2325	18,000
St James Parish						
Circle Drlg Co Inc	4	gas-btne	800	Brwstr N-75	960	11,000
Delta Drlg Co	31	gas-btne	1020	Emsco J-1000	1260	13,000
Glasscock-Wilson Inc	7	gas	1200	Natl 80-B	800	12,500
Carnes W Weaver Drlg Co	2	gas-btne	900	Ideco	—	11,000
St Landry Parish						
Pernie Bailey	2	gas	800	Unit U-40	—	11,000
Crow Drlg & Prod Co	5	dsl	825	Brwstr N-7	825	9,000
St Martin Parish						
Falcon Seaboard Drlg Co	12	stm	1200	Natl 2310½ FE	2000+	20,000
Gilger Drlg Co	4	stm	1000	Emsco	1000+	14,000
Howell & Howell	5	gas	—	Unit U-15	—	9,000
Rowan Drlg Co Inc	Bge 13	dsl-elec	1700	Emsco FCA	2700	18,000
Southeastern Drlg Corp	20-Bge 6	dsl	1200	"Oilwell" 96	1100	16,000
Carnes W Weaver Drlg Co	Bge 1	dsl	2000	"Oilwell" 96	1700	16,000
St Mary Parish						
Brewster-Bartle Drlg Co Inc	8	dsl	—	"Oilwell" 96	1500	16,000
Bullard Drlg Co Inc	2	stm	1000+	Emsco ECB	1000+	16,000
Circle Drlg Co Inc	Bge 6	dsl-elec	2300	Ideco E2500	2750	20,000
Clegg & Hunt	8	dsl	—	—	1275	18,000
Delta Drlg Co	14	stm	900	Ideco Big Gnt	1690	15,000
	19	stm	1200	Natl 34-10-FE	1690	15,000
Harry L Edwards Drlg Co	4	stm	1000+	Alco BIW 12	1000+	15,000
Buster Gardner Drlg Co Inc	2	dsl	—	Beth Tornado	—	15,000
	3	dsl	—	Beth 1013	—	17,500
C G Glasscock Drlg Co	4	dsl	1700	Natl 125	—	16,000
Hawkins-Wilkins Prod Co	2	dsl	—	Ideco PR-1050	900	15,000
M M Lindsey Drlg Co	1	gas	380	Brwstr N-55	—	7,500
Penrod Drlg Co	Bge 46	dsl-elec	1250	Emsco ECB	1250	20,000
Southeastern Drlg Corp	14-Bge 1	dsl	1200	"Oilwell" 96	1600	18,000
Wheless Drlg Co	Bge 9	dsl	1300	Natl 130	1300	16,000
	Bge 14	dsl	1300	Emsco J-1400	1400	16,000
Tensas Parish						
Big Chief Drlg Co	31	gas	1545	Emsco 800	1515	13,500
Butler Johnson Inc	4	gas	500	Brwstr N4	350	6,500
Jett Drlg Co Inc	109	gas-gaso	1000	Brwstr N-7	800	9,500
	112	dsl	1200	Brwstr 55	800	9,000
Keoughan Drlg Co Inc	1	dsl	520	Crdwll O	—	8,500
Montgomery Drlg Co	1	gas-btne	700	Emsco GA-500	600	9,500
Pyburn Drlg Co	2	gas	250	Wilson	800	9,000
Terrebonne Parish						
Brewster-Bartle Drlg Co Inc	7	dsl	—	"Oilwell" 96	1500	16,000
	11	dsl	—	"Oilwell" 96	1500	16,000
Continental Drlg Co	6	dsl	650	Emsco GB-500	650	11,000
Continental Shelf Drlg Corp	Belle Claire	dsl	1700	Beth 1013	1950	18,000
Cron & Gracey Corp	3	dsl	—	TIW CT-5	520	8,000
Delta Drlg Co	16	dsl	1200	Beth MC-950	1400	15,000
	35	gas-btne	1200	Emsco J-1100	1200	15,000
Doc Drlg Corp	Bge NEVA	dsl	1500	Beth 1013	1500	18,000
Blackie Drlg Co Inc						
Neva-Andre Drlg Corp						
Gilger Drlg Co	6	stm	1200	Natl	1200	15,000
C G Glasscock Drlg Co	2	dsl	1200	Natl 80-B	—	12,000
	14	dsl	1500	Natl 75	900	12,000
Gracey-Hellums Corp	Bge 3	dsl	1775	Unit U-12-20	1800	20,000
Grey Wolf Drlg Co	2	dsl-elec	1250	Alco BIW 12	1750	15,000
	3	stm	1050	Alco BIW 12	—	13,500
Kelly Drlg Co Inc	2	pwr	600	"Oilwell" 96	150	18,000
	3	pwr	825	"Oilwell" 96	1500	18,000
Penrod Drlg Co	33	gas-btne	—	—	1230	12,000
Rowan Drlg Co Inc	Bge 18	stm	1800	Emsco ED	750	18,000
	Bge 20	dsl	1120	Natl 75	1300	12,000
Southeastern Drlg Corp	9-Bge 2	dsl	1200	"Oilwell" 96	1600	18,000
Sunnyland Contr Co Inc	11	dsl	—	Ideco H-750	520	11,000
Carnes W Weaver Drlg Co	7	stm	—	Unit U-117B	—	14,000
C B Webster Drlg Co	4	stm	1200	Natl FE-34-10	1200+	15,000
	5	stm	1350	Natl FE-23-10½	1200+	15,000
Wheless Drlg Co	7	stm	1000+	Emsco UBL S	1000+	15,000
	Bge 8	dsl	1300	Natl 130	1455	16,000
	15	dsl	1975	Natl 130	1455	16,000
Union Parish						
Arrow Drlg Co	16	gas-elec	840	Emsco	—	10,000
Monroe Drlg Co Inc	1	stm	260	Natl U-2	—	12,000
Vermilion Parish						
Brewster-Bartle Drlg Co Inc	3	dsl	—	"Oilwell" 96	1500	16,000
	14	dsl	—	Natl 125	—	16,000
Clegg & Hunt	6	stm	—	Natl 9-DMB	—	14,000
Comet Drlg Co	1	stm	1200	Ideco Big Gnt	—	16,000
Dixie Drlg Co Inc	1	dsl	1350	Beth	1500	17,500
	3	gas	1350	Beth	1800	17,500
A W Eggleston Inc	1	gas-btne	600	Natl 60A	600	9,500
Falcon Seaboard Drlg Co	Bge 4	dsl-elec	2700	Beth B-3661	2000	22,500
C J Foster Drlg Co Inc	1	stm	—	National	1000+	18,000
Wm Hawkins Drlg Co	2	gas-btne	300	Unit U-15	485	9,000
Penrod Drlg Co	16	gas-btne	—	—	1500	15,000
Webster Parish						
Cook Drlg Co	19	gas-btne	900	Wisn Titan	975	12,500
Crow Greyhound Drlg Co Inc	3	dsl	1000	Brwstr N-7	825	8,000
Penrod Drlg Co	3	dsl	—	—	730	9,000
	11	gas	—	—	1425	12,000
	35	stm	—	—	—	15,000
Woolf & Magee Inc	1	stm	1000+	Natl 34-10FE	1200+	15,000
MICHIGAN						
Allegan County						
Gordon Drlg Co	3	gas-LPG	500	"Oilwell" 64-B	400	5,000
Crawford County						
Fen-Par Expl Co Inc	2	dsl	100	Failing 1500	100	1,500
Hillsdale County						
Gordon Drlg Co	12	dsl	600	Wisn Giant	550	10,000
Union Rotary Corp	4	dsl	475	Natl 50	575	7,500
Isabella County						
Gordon Drlg Co	8	gas-LPG	600	Natl 50-A	500	9,000
Kent County						
Gordon Drlg Co	7	gas-LPG	500	"Oilwell" 64-B	400	5,000
Mason County						
Fen-Par Expl Co Inc	1	dsl	100	Failing 1500	100	1,500
Oceana County						
Bernhardt Drlg Co	1	dsl	300	Failing 2500	300	3,500/2⅞"
Ogemaw County						
Union Rotary Corp	8	dsl	475	Natl 50	575	7,500
Osceola County						
Gordon Drlg Co	11	dsl	600	Wisn Roadair	500	10,000
Ottawa County						
Gordon Drlg Co	1	gas-LPG	250	"Oilwell" 64	225	4,000
St Clair County						
Union Rotary Corp	5	dsl	475	Natl 50	575	7500
Wayne County						
Union Rotary Corp	3	gas-LPG	200	Natl 40	180	4,000
MISSISSIPPI						
Adams County						
Milton Crow Inc	6	dsl	260	Brwstr N-4	260	5,500

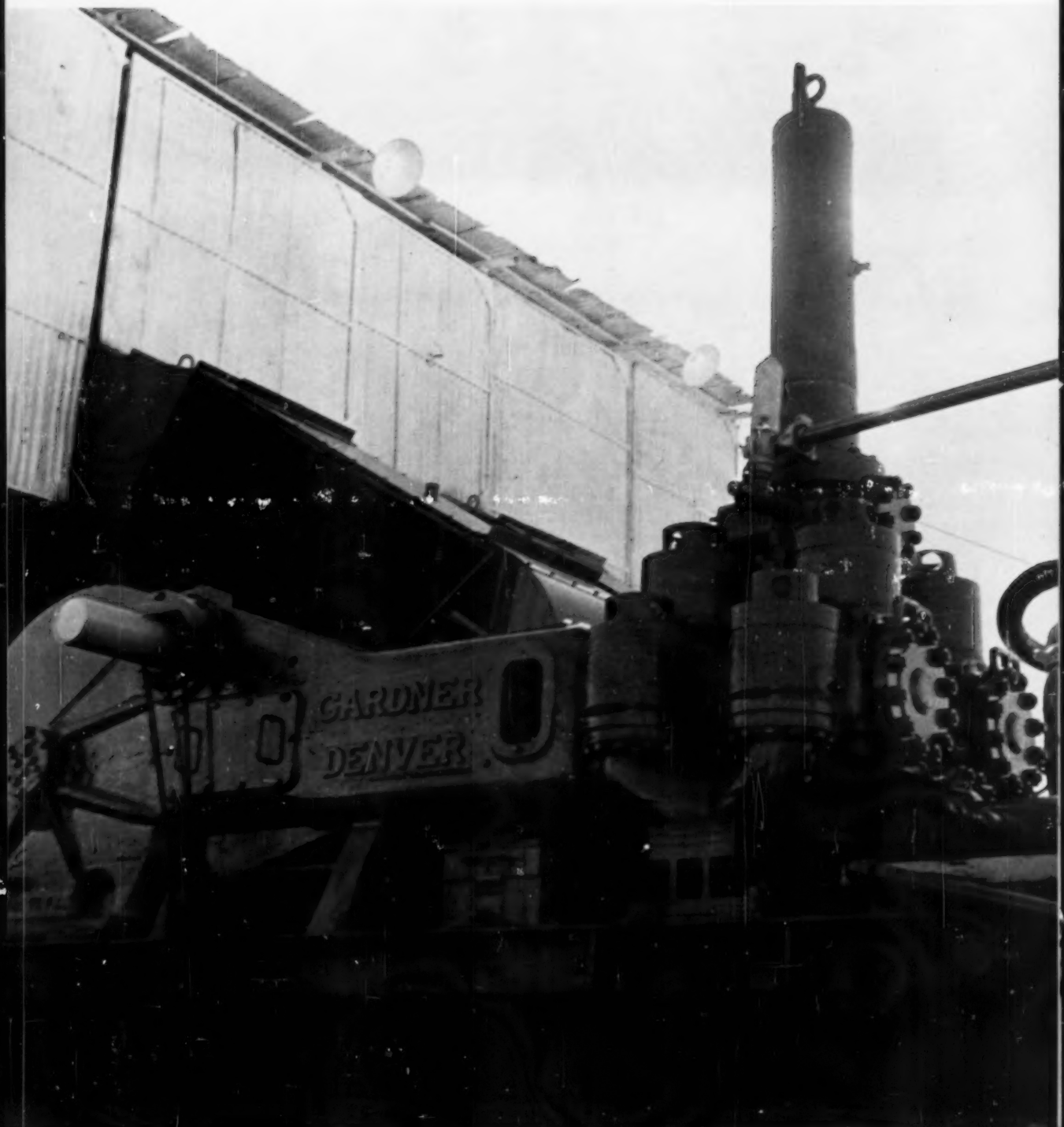
Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Fortenbery Drlg Co Inc	1	dsl	500	Ideco H-40	300	7,500
	5	dsl	500	Wisn Giant	350	9,000
Wilson Drlg Co Inc	1	dsl	212	Ideco H-35-D	424	8,500/3½
Chickasaw County						
Dorris Ballew Inc	8	dsl	1380	Natl 125	1725	16,000
Clarke County						
Dorris Ballew Inc	4	dsl	760	Wisn Titan	1900	15,000
Clay County						
Drlg & Expl Co of Del Inc	37	gas-gaso	1200	Emsco GB-800	900	12,000
Franklin County						
Jett Drlg Co Inc	107	dsl	600	Brwstr N-45	400	7,000
Woolf & Magee Inc	11	gas-btne	275	Beth S-45	275	10,000/2⅛"
Greene County						
Larco Drlg Co	2	dsl	1200	"Oilwell" 96	1200	14,000
Hinds County						
Larco Drlg Co	7	gas	900	"Oilwell" 96	1000	12,500
Jasper County						
Zach Brooks Drlg Co	8	gas	2600	Brwstr N-12	2600	18,000
Jefferson County						
Zach Brooks Drlg Co	1	gas-btne	1350	Brwstr N-95	1350	14,000
Jefferson Davis County						
Larco Drlg Co	6	dsl	1200	"Oilwell" 96	1600	18,000
Jones County						
Drlg & Expl Co of Del Inc	39	gas-gaso	1200	Emsco J-1100	1050	15,000
Jett Drlg Co Inc	106	dsl	1600	Brwstr N-95	1400	13,000
Larco Drlg Co	4	dsl	1200	"Oilwell" 96	1600	18,000
Lincoln County						
Dorris Ballew Inc	2	dsl	760	Wisn Titan	1300	12,500
Zach Brooks Drlg Co	7	dsl	1350	Brwstr N-75	1350	12,500
Drlg & Expl Co of Del Inc	25	gas-gas	1000	Natl 100	900	12,000
Marshall R Young Drlg Co	1	—	740	Natl 75	648	10,000
	6	stm	2888	Natl 34	1480	16,000
	7	stm	2888	Natl 34	1480	16,000
	8	—	945	Wisn Titan	1122	14,000
	12	—	740	Natl 50-A	558	8,000
Monroe County						
A W Williams Drlg Co Inc	1	dsl	186	Joy 300	200	5,500/2⅛"
Pearl River County						
Crawford Drlg Co	3	stm	—	"Oilwell" 96	500	10,500
Justiss-Mears Oil Co Inc	9	gas	650	Emsco GA-300	560	11,000/4"
Sunnyland Contr Co Inc	8	gas-gaso	—	Crdwll D	312	8,000
Pike County						
Dorris Ballew Inc	1	dsl	760	Wisn Titan	1300	12,500
Crow Drlg & Prod Co	16	dsl	1100	Brwstr N-10	1100	12,000
Sunnyland Contr Co Inc	12	dsl	1120	Ideco H-525 SC	1000	10,000
Marshall R Young Drlg Co	3	—	900	Natl 75	830	10,000
Rankin County						
Arrow Drlg Co	5	gas	1250	Emsco	—	14,000
Jett Drlg Co Inc	111	dsl	2000	Natl 125	1200	15,000
Sharkey County						
Woolf & Magee Inc	10	gas-btne	275	Beth Breeze	275	10,000/2⅛"
Simpson County						
Jett Drlg Co Inc	110	dsl	1400	Brwstr N-95	1400	14,000
Smith County						
Cook Drlg Co	20	gas-btne	900	Wisn Titan	975	12,500
Marshall R Young Drlg Co	5	—	945	Wisn Titan	1122	14,000
	11	—	945	Wisn Titan	1122	14,000
Stone County						
Drlg & Expl Co of Del Inc	41	gas-gaso	1500	Emsco J-1100	1050	15,000
Wayne County						
Cook Drlg Co	16	gas-btne	1050	Wisn Titan	975	12,500
Drlg & Expl Co of Del Inc	35	gas-gaso	1200	Emsco GB-800	900	12,000
Larco Drlg Co	5	gas	800	"Oilwell" 76	1000	10,000
Sunnyland Contr Co Inc	7	dsl	—	Ideco H-40	450	8,000
Yazoo County						
A W Williams Drlg Co Inc	2	dsl	495	Frnks 6000	495	8,500/4"
MONTANA						
Carbon County						
Anschutz Oil Co Inc	7	gas	900	Unit U-15	650	8,500
True Drlg Co	9	gas-gaso	1200	Unit U-40	1200	11,000
Dawson County						
J D Sprecher	2	dsl	900	Emsco J-750	900	9,500
Fallon County						
Zach Brooks Drlg Co	6	dsl	1300	Brwstr N-75	1300	12,500
Hewit-Gulick Drlg Co	2	dsl	970	Natl 80	900	12,000
Roden & McRae Drlg Corp	3	dsl	1175	Emsco GB-800	900	12,500
	4	dsl	1175	Emsco GB-800	900	12,500
J D Sprecher	4	dsl	1000	Natl 80-B	1000	12,000
	6	dsl	750	Emsco A-550	750	9,000
Glacier County						
Kullberg & Otthouse Inc	1	dsl	300	Unit U-15	—	7,500
Musselshell County						
Hose-Austin Drlg Corp	2	dsl	300	Natl T-32	320	5,000/3½"
Pondera County						
Grannell Drlg Co	1	dsl	450	Unit U-15	450	6,000
Roosevelt County						
Zach Brooks Drlg Co	3	dsl	900	Brwstr N-7	900	8,500
Calvert Drlg Inc	23	dsl	350	Ideco H-526	600	8,500
Teton County						
Anschutz Oil Co Inc	11	gas	1000	Wisn Giant	700	8,500
Valley County						
Oien Oil Corp	3	dsl	500	Natl T-20	280	5,000
Wibaux County						
Helmerich & Payne Inc	15	dsl	975	"Oilwell" 76	1000	11,000
NEBRASKA						
Banner County						
Garvey Drlg Co	16	dsl	300	Wisn Roadair	450	7,000/3½
Lewis Bros Inc	1	dsl	376	Crdwll 1-450	476	7,500
Cheyenne County						
Herndon Drlg Co	2	gas	600	Natl 50-A	750	10,500
Hays County						
Earl F Wakefield	3	dsl	440	Wisn Gnt Rdair	440	6,000
Kimball County						
Baird & Pfeifer Drlg Co	1	dsl	800	Unit U-15	—	9,500
Exeter Drlg Co	1	dsl	325	Emsco GA-350	425	7,000
Garvey Drlg Co	19	dsl	300	Wisn Roadair	450	7,000/3½"
	20	dsl	300	Wisn Mogul 42	450	7,000/3½"
Don Johnston Drlg Co	4	gas-btne	650	Natl 50	650	7,500
Lewis Bros Inc	2	dsl	376	Unit U-15	476	6,500
Miracle-Fifer Drlg Co	1	btne	300	Unit U-15	660	8,500
Murfin Drlg Co	5	dsl	450	Emsco 500	520	9,000
Don M Rounds Drlg Co Inc	2	dsl	900	Crdwll 0	900	9,000
Richardson County						
Nemaha Oil Co	1	dsl	370	Frnks SAL 3000	370	4,500/3½"
Scotts Bluff County						
Don Johnston Drlg Co	1	dsl	270	Natl T-12	195	5,000
Sheridan County						
Earl F Wakefield	5	gas-btne	550	Wisn Gnt	550	6,500
NEVADA						
Churchill County						
Barry Well Drlg Co	2	dsl	200	—	—	3,000/3½"
Eureka County						
Colorado Wyoming Drlg Co	1	dsl	300	Natl 50-A	600	9,000
Nye County						
Casey & Montgomery Inc	A	dsl	900	Unit U-15	350	6,500
NEW MEXICO						
Chaves County						
A W Thompson Inc	9	gas	650	Clark Pr-1000	1050	13,500
Eddy County						
Great Western Drlg Co	34	dsl	495	Unit U-40	1200	10,000
	40	gas	450	Wisn Atlas	840	10,000
Johnn Drlg Co	6	gas	850	Brwstr N-95	1300	14,000
Carl B King Drlg Co of Tex	12	gas-gaso	1000	Natl 75	1000	12,500
Lee Drlg Co	4	gas-gaso	700	Natl 75	—	10,000
Parker Drlg Co	45	gas	—	Natl L-125	1400	15,000
Rowan Drlg Co Inc	12	gas-btne	1260	Natl 100	1680	14,000
	28	gas-btne	1300	Natl 125	1530	15,000
S P Yates Drlg Co	3	dsl	350	Natl T-12	250	4,000
Hidalgo County						
Durham Drlg Co Inc	4	gas	1250	Ideco 7-11	1450	15,000
Lea County						
Henry Black Drlg Co Inc	5	gas	300	Emsco 300	330	6,000
	7	gas	1050	Natl 100	1350	14,000
Brantly Drlg Co Inc	3	gas	700	Brwstr N-75	750	11,000
	7	gas	975	Beth 450	1125	12,500
C B Drlg Co	3	gas	650	Emsco 500	650	9,000
Cactus Drlg Corp of Tex	4	gas-btne	1050	"Oilwell" 76	1050	12,500
	7	gas-btne	1275	"Oilwell" 96	1050	15,000
	9	gas-btne	800	Brwstr N-75	—	12,500
Delta Drlg Co	6	gas-btne	800	Emsco J-750	750	9,500
	9	gas-btne	936	Natl 100	800	12,000
Denver Drlg Corp	2	gas	550	Natl 50	550	8,500
Donnell Drlg Co	5	gas-btne	650	Unit U-15	650	8,000
	12	btne	400	Beth S45E	—	5,000
Durham Drlg Co Inc	3	gas	1150	Unit U-20	1300	14,000
Frank Frawley Drlg Co	2	gas	—	Unit U-20	1050	13,000
Great Western Drlg Co	12	gas-gaso	1350	Unit U-20	1755	16,000
	25	gas-gsao	775	Unit U-194A	1530	15,000
Helmerich & Payne Inc	25	gas	1100	"Oilwell" 96	1100	14,000
	32	gas	1100	"Oilwell" 96	1100	14,000
	43	gas	900	"Oilwell" 76	1100	11,000
Highland Drlg Co	2	gas	325	Ideco H-35	375	5,600
Jal Oil Co Inc	1	gas	660	Wisn Giant	660	9,000/3½"
	2	gas	470	Wisn Giant	290	5,000
	3	gas	585	Hou Prtble	300	5,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Kerr-McGee Oil Ind Inc	7	gas	900	Natl 75	818	11,500
Carl B King Drlg Co of Tex	7	gas-gaso	1000	Natl 100	1000	13,500
	20	gas	2100	"Oilwell" 96-16	2100	20,000
La Mance Drlg Co	1	btne	350	Frnks 5000	—	5,000
Llano Drlg Co	5	gas	—	Natl 100	1050	14,000
Lomax Drlg Co	111	gas-btne	850	Natl 75	850	10,500
Lowe Drlg Co	4	gas	1800	Natl 125	—	17,500
	6	gas	500	Unit U-15	—	7,500
	8	gas	1500	Natl 80	—	15,000
	9	gas	2000	Natl 125	—	17,000
	10	gas	1000	Wilson	—	12,500
	11	gas	1250	Natl 100	—	12,500
McAlester Fuel Co	—	btne-gas	—	Emsco J-1100	1050	14,000
	—	btne-gas	—	Natl 100	1050	14,000
B L McFarland Inc	11	gas	1000	Natl 100	—	13,000
McQueen & Stout Drlg Co	15	LPG	225	Crdwll RL	185	4,500
Moran Oil Prod & Drlg Corp	3	gas	—	Unit U-15	800	8,500
	4	gas	—	Unit U-34	300	5,000
R Olsen	4	gas	1101	Wisn Titan	1101	12,500
Parker Drlg Co	42	gas	—	Natl L-100	1400	14,000
	49	gas	—	Natl L-125	1400	15,000
	51	gas	—	Natl 50	700	9,000
	52	gas	—	"Oilwell" 76	1400	12,500
	53	gas	—	Natl 75	1000	11,000
Robinson Brothers Drlg Co	3	gas	300	Brwstr N-55	500	6,500
Rowan Drlg Co Inc	7	gas-btne	1260	Natl 100	1680	14,000
Schafer Drlg Co	3	gas-gaso	400	Unit U-15	600	10,000
Schoenfeld-Hunter-Kitch Drlg Co	6	LPG-gas	—	Beth 650	1000	14,000
A W Thompson Inc	2	gas	650	Beth 10-13	1650	16,000
	3	gas	650	Emsco 800	1050	13,500
	4	gas	650	Beth 810	1050	13,500
	11	gas	650	Beth 450	1050	13,500
	12	gas	350	Emsco 350	600	7,000
Tri-Service Drlg Co	5	gas	825	"Oilwell" 76	825	10,000
	6	gas	1350	"Oilwell" 96	1350	16,000
Warton Drlg Co	3	gas	970	Natl 110	1600	14,000
Western Serv Drlg Co Inc	1	gas-btne	340	Natl 50	360	5,000
	8	gas-btne	600	Beth MC-650	700	11,000
	11	gas-btne	1000	Beth 810	1100	11,000
S P Yates Drlg Co	1	dsl	350	Unit U-34	350	5,000
	2	dsl	350	Unit U-15	540	6,500
Mora County						
B F Allison Drlg Co	4	gas-btne	900	Brwstr N-75	900	11,000
Rio Arriba County						
Anschutz Oil Co Inc	2	dsl	900	Wisn Giant	560	8,500
Arapahoe Drlg Co	1	gas-btne	300	Natl T-32	320	6,000
	3	gas-btne	300	Wisn Mogul	275	5,000
Brannon & Murray Drlg Co	1	gas-LPG	550	Brwstr N-55	550	8,500
D-K Drlg Co	2	gas	675	Natl 50	675	7,500
Empire States Drlg Corp	1	gas	225	Unit U-34 Trlr	225	5,000
Fleeger Drlg Inc	1	dsl	325	Beth Twister	600	8,500
Great Western Drlg Co	32	gas	353	Unit U-15	750	7,500
	36	gas-gaso	320	Unit U-15	675	7,500
Nichols Drlg Co	3	gas-btne	700	Natl 50-A	700	9,000
Paul F Rutledge	2	gas	650	Beth M-58	650	10,500
	5	gas	650	Natl 50	650	7,000
San Juan Drlg Co	10	gas	570	Natl 50	570	7,500
	14	dsl	340	Frnks SA-4500	400	5,000
	15	gas	570	Unit U-15	570	7,500
Roosevelt County						
Kerr-McGee Oil Ind Inc	34	dsl	300	Frnks LTX-5000	300	5,000
Lowe Drlg Co	1	gas	500	Unit U-15	—	7,500
B L McFarland Inc	12	gas	500	Brwstr N-55	—	8,000
San Juan County						
Black Hills Drlg Co Inc	1	dsl	450	Emsco GA-350	—	7,500
Brannon & Murray Drlg Co	2	gas-LPG	550	Emsco GA-350	550	6,500
	3	gas-LPG	350	Brwstr N-4	250	5,000
Carroll Drlg Co Inc	6	dsl	—	Unit U-15	—	6,500
	8	dsl	—	Natl 75	—	9,500
	10	dsl	—	Emsco	—	9,500
Durham Drlg Co Inc	1	gas	500	Unit U-15	660	8,500
Empire States Drlg Corp	2	gas	530	Ideco H-35	530	6,500
	3	gas	225	Cardwell L	225	4,000
Exploration Drlg Co	4	gas	625	Unit U-15	600	8,000
Fleeger Drlg Inc	5	dsl	360	Frnks	500	5,000
	6	dsl	450	Unit U-15	600	8,500
	7	dsl	360	Beth [illegible]	500	5,000
Gardner Bros Drlg Co Inc	9	gas-btne	450	Unit U-15	675	7,000
	19	gas-btne	185	Crdwll R	200	3,300
Great Western Drlg Co	31	gas-gaso	307	Unit U-15	840	9,000
Herndon Drlg Co	4	gas	480	Emsco G-450	630	7,000
Lynn Drlg Co	1	gas-btne	300	Natl 50	450	7,000
	2	gas-btne	425	Natl 75	700	10,000
	3	gas-btne	1000	Natl 75	1000	11,500
Moran Bros Inc	3	gas	700	Emsco G6-350	750	8,500
	10	gas	550	Emsco GA-350	650	8,500
Nye & Snell Drlg Co	2	dsl	320	Wisn M-46	320	5,000
San Juan Drlg Co	3	gas	570	Natl 50	570	7,500
	4	gas	570	Natl 50	570	7,500
	5	gas	213	Natl 40	213	5,000
	8	gas	570	Natl 50	570	7,500
	12	gas	213	Brwstr 70	213	4,000
Schafer Drlg Co	4	gas-gaso	200	Unit U-34	200	6,000
San Miguel County						
Henson Drlg Co	1	btne	825	Unit U-15	825	7,500
Sojourner Drlg Corp	1	btne	218	Unit U-15	—	7,500
NEW YORK						
Schuyler County						
Gordon Drlg Co	S-7	dsl	300	Crdwll S	300	4,500
Steuben County						
Delta Drlg Co	39	gas-btne	500	Natl 75	1000	9,500
NORTH DAKOTA						
Brinkerhoff Drlg Co Ltd	2	dsl	370	Natl 50-A	450	8,000
Billings County						
Helmerich & Payne Inc	29	gas	950	Natl 75CA	1100	11,000
Burke County						
Anschutz Oil Co Inc	5	dsl	300	Wisn Giant	280	5,500
Cactus Drlg Corp Ltd	2	gas-btne	675	Unit U-15	675	8,500
Calvert Drlg Inc	22	gas-btne	320	Ideco H-35	330	5,500
	24	gas-btne	600	Unit U-15	600	9000
Hose-Austin Drlg Corp	3	gas	450	Unit U-15	550	7,000
Lohmann-Johnson Drlg Co Inc	4	dsl	300	Unit U-15	440	5,500
Precision Drlg Co Ltd	7	dsl	550	Ideco 525	550	7,500
Paul F Rutledge	1	gas	975	Beth M-450	975	12,000
Divide County						
Cactus Drlg Corp Ltd	1	gas-btne	450	Brwstr N-55	450	7,000
Penrod Drlg Co	19	dsl	—	—	730	9,000
Dunn County						
Anschutz Oil Co Inc	15	dsl	1000	"Oilwell" 76	1000	12,000
McKenzie County						
Anschutz Oil Co Inc	14	gas	900	Brwstr N-7	600	10,000
Calvert Drlg Inc	25	gas-btne	1050	Beth 810	1100	12,500
Helmerich & Payne Inc	33	gas	850	"Oilwell" 76	1100	11,000
Gabe McCall Drlg Co	3	gas	1200	Natl 80	1200	10,000
Penrod Drlg Co	31	dsl	—	—	1200	10,000
Rowan Drlg Co Inc	5	gas-btne	840	Natl 75	1120	11,000
	15	gas-btne	1140	Natl 75	1503	11,000
	23	gas-btne	1140	Natl 75	1503	11,000
Paul F Rutledge	3	gas	650	Beth M-450	650	12,000
Mountrail County						
Anschutz Oil Co Inc	12	gas	830	Brwstr N-45	530	7,000
Renville County						
Expl Drlg Co	6	gas	310	Beth S-50	200	5,500
Stark County						
R L Manning Co	8	dsl	550	Emsco G-500	550	7,500
Williams County						
Expl Drlg Co	9	gas	310	Beth S-50	250	5,500
Helmerich & Payne Inc	8	gas	600	Natl 55	800	9,000
Penrod Drlg Co	5	gas-btne	—	—	—	15,000
	9	dsl	—	—	385	6,000
Rowan Drlg Co Inc	27	gas-btne	1350	Natl 125	1530	15,000
OHIO						
Ashtabula County						
Union Rotary Corp	7	gas-LPG	220	"Oilwell" 64	220	6,000
Wayne County						
D B Lesh Drlg Co	2	dsl	320	Natl T-25	320	5,500
OKLAHOMA						
Alfalfa County						
Barrett Petroleum Co	2	gas-gaso	—	Natl 50	450	6,800
Davon Drlg Co	5	gas-LPG	400	Brwstr N-45	320	7,500
Graham-Michaelis Drlg Co	8	dsl	400	Crdwll D	400	5,000
Lohmann-Johnson Drlg Co Inc	8	dsl	300	Natl 32	550	7,500
Viersen & Cochran	12	gas	325	Natl T-25	225	5,500
Beaver County						
Arrow Drlg Co	10	gas	560	Emsco 500	—	8,000
Beckman Inc	19 (wo)	—	180	MIW P-42	175	10,000
Big Chief Drlg Co	24	gas	750	Unit U-15	800	9,500
	33	gas	1250	Natl 55	1250	11,000
Garvey Drlg Co	22	dsl	300	Wisn Mogul 42	450	7,000
Graham-Michaelis Drlg Co	2	dsl	500	Unit U-15	500	7,000
	10	dsl	600	Unit U-15	600	9,000
Harper-Turner Drlg Co	1	gas	650	Wisn Titan	—	11,000
	8	gas	480	Natl 50	—	8,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Helmerich & Payne Inc	36	gas	500	Emsco GB-500	52 700	9,000
Midwestern Drillers Inc	3	dsl	370	Unit U-15	750	8,500
	7	dsl	370	Unit U-15	750	8,500
R W Rine Drlg Co	5	gas-btne	520	Brwstr N-55	550	8,500
Schafer Drlg Co	1	gas-gaso	1200	Unit U-40	900	12,000
Viersen & Cochran	5	gas	500	Natl 50	650	9,000
Wagner & Wyant Drlg Co Inc	1	dsl	300	Unit U-15	450	8,000
Earl F Wakefield	6	dsl	960	Wisn Atlas Rdair	960	13,000
Webster Drlg Co	6	gas-btne	600	Beth	600	7,500
Kidd Williams Drlg Corp	11	gas	775	Wisn Atlas	1200	12,500
Beckham County						
Beckman Inc	17 (wo)	gas	150	MIW P-42	200	10,000 2⅛
Helmerich & Payne Inc	47	gas-btne	2000	"Oilwell" 96-16	2000	20,000
Parker Drlg Co	57	gas	—	Emsco 750	1000	10,000
Blaine County						
Bryant-Hayward Drlg Co	1	gas	675	Natl 50	675	8,500
Bryan County						
Hollman Drlg Co	4	gas	255	Unit U-15	500	7,500
Caddo County						
Arrow Drlg Co	25	gas	840	Ideco 1000	—	10,000
Big Chief Drlg Co	2	gas	1875	Natl 125	1815	16,000
C N P Drlg Co	1	gas	185	Wichtex	145	3,500
Crowe Drlg Co	2	gas	200	Natl T-12	175	4,000
Graham Drlg Co (Okla)	1	gas-btne	235	Wisn Mogul	285	5,000
Harper-Turner Drlg Co	9	gas	125	Crdwll	—	4,000
Helmerich & Payne Inc	38	gas	950	Natl 80	1100	11,000
Howell & Howell	9	gas	1600	Emsco A-1500	2500	25,000
Jonco Drlg Co	2	gas-btne	300	Brwstr N-3	200	4,500
Parker Drlg Co	34	gas	—	Natl L-75	800	10,000
G H Ray Well Serv	1	prop-gas	200	Wilson	200	4,500
Sherin Drlg Co	3	gas-gaso	500	Unit U-15	600	8,000
Canadian County						
Viersen & Cochran	4	gas	600	Natl 75	650	10,500
Carter County						
Berry Drlg Co	1	dsl	350	Wisn Giant	500	6,500
Fain-Porter Drlg Corp	3	gas	375	Emsco GA-250	400	6,000
Frankfort Oil Co Drlg Div	4	gas	1200	Brwstr N-95	—	16,000
	5	gas	800	Brwstr N-75	—	10,000
Graves Drlg Co	1	dsl	300	Frnks 4000-A	330	3,500
	2	gas	185	Franks	125	2,000
Ward S Merrick	1	gas	300	Wisn Giant	—	5,000
Sherin Drlg Co	2	gas-gaso	500	Unit U-15	600	8,000
	5	gas-gaso	750	Natl 55	750	9,000
Cimarron County						
Midwestern Drillers Inc	2	dsl	320	Unit U-15	600	7,500
Wagner & Wyant Drlg Co Inc	3	dsl	175	Unit U-34	300	5,000
Cleveland County						
An-Son Drlg Co	2	gas	600	Unit U-15	700	9,000
Big X Drlg Co Inc	2	gas-gaso	750	Natl 55	750	10,000
Bryant-Hayward Drlg Co	2	gas	675	Natl 50	675	8,500
	3	gas	700	Unit U-15	700	9,500
Davon Drlg Co	3	gas-LPG	500	Brwstr N-7	750	10,000
N V Duncan Drlg Co	4	gas	600	Beth 450	600	9,000
T T Eason Co Div Eason Oil Co	12	gas	1000	Natl 80-B	1000	12,000
	14	gas	750	Emsco 6-B-500	750	9,000
Fain-Porter Drlg Corp	4	gas	575	Emsco GB-500	600	8,000
Garvey Drlg Co	21	dsl	500	Unit U-15	640	8,500
Harper-Turner Drlg Co	4	gas	450	Natl 50	—	7,500
Kirkpatrick Oil Co	4	gas	504	Wisn Giant	504	10,500
Nichols Drlg Co	9	gas-btne	700	Natl 50-A	700	10,000
Nuckolls-Bell Drlg Co	3	dsl	600	Ideco H-525	704	9,000
O'Rourke-McGirl Drlg Corp	2	gas-btne	—	Unit U-15	800	8,000
Reaves Drlg Co Inc	2	gas-btne	550	Emsco G-450	—	7,500
Coal County						
Delaney Drlg Co	1	gas-btne	450	Unit U-15	450	7,500
Sherin Drlg Co	4	gas-gaso	1000	Natl 100	1050	12,000
Cotton County						
Revier Drlg Co	4	gas-btne	213	Brwstr N-3	145	3,500
Creek County						
Davon Drlg Co	4	gas-LPG	200	Brwstr N-2	290	6,500 2⅛"
Glenn Gillespie & Sons	2	gas-dsl	360	Wisn Mogul	280	6,000
Mesker Drlg Co	2	gas	185	Joy 300	160	2,500
Wade Drlg Co	1	dsl	225	Crdwll L	185	3,500
Garfield County						
Hayward Drlg Co	1	gas	200	Wilson	125	2,500
Helmerich & Payne Inc	46	gas	500	Emsco GB-500-52	700	9,000
Reaves Drlg Co Inc	5	gas-btne	550	Emsco GB-250	—	6,000
Garvin County						
Barrett Petroleum Co	5	gas-gaso	—	Brwstr N-7	750	8,500
Big Chief Drlg Co	30	gas	1545	Ideco 1050	1515	15,000
Big X Drlg Co Inc	1	gas-gaso	750	Beth MC-450	750	9,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Dearing Inc	1	gas-btne	—	Natl 50	—	7,000
	2	gas-btne	—	Natl 100	—	15,000
	4	gas-btne	—	Wilson	—	4,000
N V Duncan Drlg Co	7	gas	250	Natl 50	450	7,500
Flournoy-Haston Drlg Co	2	gas-btne	300	Unit U-15	650	8,500
Garvey Drlg Co	6	dsl	275	Unit U-15	640	8,500
Hap Drlg Co	1	gas	350	Emsco GB-500	550	8,000
Helmerich & Payne Inc	24	gas	950	Natl 80	1100	11,000
Kerr-McGee Oil Ind Inc	41	gas	970	Natl 75	832	11,500
Perkins Bros Drlg Co	2	gas-btne	—	Unit U-15	675	8,500
Sherin Drlg Co	1	gas-gaso	500	Unit U-15	600	8,000
Viersen & Cochran	7	gas	600	Wisn Titan	650	10,500
	8	gas	980	Emsco J-1000	975	14,000
Grady County						
Big Chief Drlg Co	35	gas	2610	Natl 110	2610	16,000
Falcon Seaboard Drlg Co	15	gas-btne	1100	Unit U-20	1200	16,000
General Drlg Co	5	—	—	Unit U-15	—	7,500
Helmerich & Payne Inc	44	gas	1200	"Oilwell" 96	1500	15,000
Viersen & Cochran	9	gas	1200	Emsco J-1250	1590	18,000
Dick Wegener Drlg Contr	4	gas-dsl	1900	Natl 130	1900	22,000
Kidd Williams Drlg Corp	10	gas	1400	Wisn Spr Titan	2100	21,000
Grant County						
Barrett Petroleum Co	4	dsl	—	Unit U-10	350	5,800
Davon Drlg Co	1	gas-LPG	250	Brwstr N-4	300	6,000
Lincoln Drlg Co	2	gas	325	Emsco 250	290	6,000
Viersen & Cochran	1	gas	325	Emsco G-300	450	5,800
	6	gas	255	Natl T-25	225	5,500
	14	gas	325	Natl T-25	225	5,500
Webster Drlg Co	5	gas-btne	450	Natl 50	450	7,500
Greer County						
Taylor Expl Co Inc	8	btne	—	Failing	—	2,000
Harper County						
Arrow Drlg Co	1	gas	860	Ideco 1000	—	11,500
Barrett Petroleum Co	1	gas-gaso	—	Natl 50	450	6,800
Beckman Inc	3 (wo)	gas	150	MIW P-42	200	10,000
	5 (wo)	—	180	MIW P-42	175	10,000
Calvert Drlg Inc	15	dsl	260	Ideco H-35	260	5,000
T T Eason Co Div Eason Oil Co	15	gas	450	Emsco T-250	225	6,000
Carl B King Drlg Co of Tex	11	gas-gaso	900	Natl 75	900	11,000
Hughes County						
E L & M Drlg Co	1	gas	450	Wisn Mogul	—	4,500
J & J Drlg Co	1	gas-btne	275	Beth S-45	450	4,500
Jefferson County						
Mardale Drlg Co	1	gas-gaso	185	Wichtex R-3	145	2,800
Johnston County						
Parker Drlg Co	55	gas-elec	—	Natl L-130	2000	20,000
Kay County						
Curt Brown Drlg Co	1	dsl	320	Frnks Comet	320	5,000
Folk Drlg Co	1	dsl	200	Crdwll RL	200	4,000
Glendale Drlg Co	1	gas-gaso-btne	320	Unit U-10	330	5,000
Reaves Drlg Co Inc	1	gas-btne	450	Emsco G-300	—	6,000
Kingfisher County						
Calvert Drlg Inc	19	dsl	350	Unit U-15	600	8,500
Kiowa County						
Bolin Oil Co & D H Bolin	5	gas	225	Wisn Mogul	190	4,000
Lincoln County						
Harper-Turner Drlg Co	5	gas	320	Emsco G-300	—	6,000
Indian Drlg Co	2	dsl	220	Ideco H-35-S	350	5,000
Lincoln Drlg Co	1	gas	250	Brwstr N-3	185	4,500
Wade Drlg Co	3	dsl	325	Crdwll L	225	4,500
Warren Drlg Co	2	dsl	—	Ideco H-30S	320	5,500
Logan County						
Big Chief Drlg Co	1	gas	450	JS&G Spad "Super"	450	6,500
Davon Drlg Co	2	gas-LPG	280	Brwstr N-4	320	6,500
Nuckolls-Bell Drlg Co	2	dsl	300	Ideco H-40	352	7,500
Viersen & Cochran	13	gas	325	Natl T-16	175	5,200
Warren Drlg Co	1	gaso	350	Natl T-32	—	7,000
Love County						
Arrow Drlg Co	18	gas	1260	Emsco 1250	—	14,000
Falcon Seaboard Drlg Co	24	gas-btne	1000	Beth 950	1365	16,000
	32	gas-btne	1050	Beth 650	1155	16,000
Kidd Williams Drlg Corp	5	gas	825	Wisn Atlas	900	10,000
	6	gas	925	Wisn Titan	1000	15,000
Major County						
Big Chief Drlg Co	27	gas	760	JS&G Spad Spr	760	9,000
Calvert Drlg Inc	18	gas-btne	350	Unit U-15	600	8,500
Falcon Seaboard Drlg Co	8	gas-btne	450	Beth 450	900	10,000
Lewis Drlg Co	2	dsl	550	Unit U-15	550	7,500
J S Montgomery	3	gas	1100	Natl 80	1100	12,000
Parker Drlg Co	56	gas	—	Natl L-50	700	9,000
Webster Drlg Co	4	gas-btne	750	Emsco 500	750	8,500

How to find Quality



and Service In Mud Pumps

Precision and skill of a proven manufacturer combined with the talents and know-how of a leading supply organization add up to two words . . . unexcelled service. That's the service assured by the appointment of Jones & Laughlin Supply Division as a distributor of Gardner-Denver mud pumps.

Gardner-Denver has a well deserved reputation in the oil fields as a top producer of **quality** mud pumps. Models range from 100 to 1250 hp with capacities and pressure ratings to meet any drilling requirement.

With these pumps and replacement parts available through the numerous Jones & Laughlin Supply Division stores in the United States and Canada . . . **service** is assured!

For complete information, contact your local J&L Supply store . . . office . . . or write us today, Drawer 2481, Tulsa, Oklahoma.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

J&L—A GREAT NAME IN SUPPLIES

Printed in U.S.A.

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
McClain County						
Brewster-Bartle Drlg Co Inc	15	gas	—	Emsco	—	10,000
Fain-Porter Drlg Corp	1	gas	750	Wlsn Titan	900	12,500
Falcon Seaboard Drlg Co	28	gas	1200	Beth 650	1050	16,000
Fleeger Drlg Inc	2	dsl	320	Wlsn Roadair	700	8,500
Flournoy-Haston Drlg Co Inc	3	gas	600	Wlsn Atlas	750	10,000
	4	gas-btne	700	Natl 100	1000	14,000
Goff-Leeper Drlg Co	1	gas	800	Brwstr N-75	800	12,000
	3	gas	450	Unit U-15	450	8,000
	4	gas	850	Wlsn Giant	850	12,500
Holliman Drlg Co	5	dsl	825	Emsco GB-800	1000	11,000
Slats Honeymon Drlg Co	2	gas-btne	450	Natl 80-A	—	12,000
Nichols Drlg Co	2	gas-btne	700	Natl 55	1050	12,000
Parker Drlg Co	37	gas	—	Natl L-100	1400	14,000
	38	gas	—	Natl L-100	1000	14,000
Perkins Bros Drlg Co	4	gas-btne	1200	Beth 650	1200	12,000
Viersen & Cochran	2	gas	500	Natl 55	650	10,500
	3	gas	600	Natl 75CA	650	10,500
McIntosh County						
Reed Drlg Co Inc	4	gas-gaso	300	Unit U-34	290	5,000
Murray County						
Frankfort Oil Co Drlg Div	3	gas	900	Brwstr N-75	—	10,000
Noble County						
An-Son Drlg Co	3	gas	400	Beth Breeze	250	4,500
Chambless-Rosen Drlg Co	1	gas-btne	225	Crdwll RL	200	5,000
Goe Drlg Co	3	dsl	275	Carson	195	3,500
Dave Morgan Drlg Co	—	LPG-gas	350	Natl T-32	320	6,000
Reed Drlg Co Inc	1	gas-gaso	220	Unit U-34	235	5,000
Target Drlg Corp	1	gas-btne	225	Unit U-34	195	5,000
Okfuskee County						
Doak Drlg Co	2	btne-gas	270	Natl T-20	250	4,500
Unit Drlg Co	1	gas-btne	290	Unit U-34	300	5,500
Oklahoma County						
N V Duncan Drlg Co	2	gas	600	"Oilwell" 64-B	600	9,000
Falcon Seaboard Drlg Co	26	dsl	225	Beth Twister	212	6,500
Harper-Turner Drlg Co	2	gas	450	Natl 50	—	7,500
	3	gas	450	Natl 50	—	7,500
Okmulgee County						
Smallwood & Son	1	gas-btne	145	Failing 1500	130	1,750
Twinoak Drlg Co	1	dsl	190	Frnks	190	3,500
Osage County						
Curt Brown Drlg Co	2	dsl	320	Frnks Comet	320	5,000
Doak Drlg Co	3	btne-gas	270	Natl T-20	250	4,500
Falcon Seaboard Drlg Co	19	gas-btne	185	Unit U-34	194	5,000
Glenn Gillespie & Sons	6	gas	290	Unit U-34	290	4,500
	7	dsl	300	Frnks 658TRD	225	4,000
Goe Drlg Co	2	gas-btne	200	Wlsn	145	3,250
John Heard & Co Inc	2	gas-LPG	270	Natl T-12	212	3,500
R L Horn & Sons Drlg Co	1	dsl	185	Frnks Comet	300	5,500
	3	gas	185	Brwstr N-3	165	5,000
Jackson Drlg Co	3	gas	400	Wlsn Mogul	400	5,500
Al Johnson Drlg Co	2	btne	325	Mayhew	200	3,500
Mesker Drlg Co	1	gas	214	Joy 300	170	2,500
Reed Drlg Co	3	gas-gaso	185	Unit U-34	202	4,000
Service Drlg Co	11	LPG	185	Crdwll Trlrmt	125	2,500
Triad Drlg Co	3	gas-btne	250	Beth S-45	250	5,500
Pawnee County						
John Heard & Co Inc	1	gas-LPG	240	Brwstr N-4	212	3,500
Reaves Drlg Co Inc	3	gas-btne	225	Emsco GB-60-T	185	4,500
Payne County						
Dudley & Heath Drlg Co	6	dsl	265	Crdwll S	320	5,500
Foster Drlg Co Inc	1	dsl	265	Natl T-16	265	5,000
Glenn Gillespie & Sons	1	gas	360	Unit U-34	225	4,500
	3	dsl	425	Wlsn Mogul	280	6,000
Hap Drlg Co	2	gas	300	Brwstr N-4	200	5,000
Indian Drlg Co	1	btne	220	Ideco H-25	250	4,000
Pete Morris Drlg Co	1	dsl-gas	550	Wlsn Giant	550	6,000
O'Rourke-McGirl Drlg Co	1	gas-btne	—	Unit U-10	450	6,000
Service Drlg Co	9	dsl	320	Natl	175	4,000
Pontotoc County						
Don Clawson	1	gas-btne	240	Brwstr N-4	185	3,500
Pottawatomie County						
Barrett Petroleum Co	3	dsl	—	Wlsn Giant	300	5,500
Johnson-Bates Drlg Co	2	gas	300	Unit U-34	300	5,000
Reed Drlg Co Inc	2	gas-gaso	—	Crdwll D	410	5,000
Rogers County						
Overby Drlg Co Inc	1	dsl-btne	180	Mayhew 1000	—	1,000
Seminole County						
Delaney Drlg Co	2	gas-btne	225	Unit U-34	225	5,000
Johnson-Bates Drlg Co	1	gas	245	Unit U-34	300	4,500
Jonco Drlg Co	1	gas-btne	350	Emsco 160	250	5,500
Kaybert Drlg Co	1	gas	225	Beth Breeze	245	5,000
Melco Drlg Co	1	btne	265	Brwstr N-35	185	5,000
	2	btne	265	Brwstr N-35	185	5,000
Poteet Wysor & Eckles Inc	1	gas-btne	225	Unit U-34	185	5,000
Reed Drlg Co Inc	6	gas-gaso	240	Natl T-12	180	4,500+
Seran & Howard Drlg Co	1	gas	225	Beth	200	5,000
Stephens County						
Bryant-Hayward Drlg Co	4	gas	900	Brwstr N-75	900	12,000
Crowe Drlg Co	1	gas	175	Wlsn Super 38	175	4,000
R A Davenport Drlg Contr	2	gas-btne	145	Wichtex R-4	145	2,500
Falcon Seaboard Drlg Co	Z-3	gas-btne	1200	Beth 950	1600	18,000
Goff-Leeper Drlg Co	2	gas	225	Brwstr N-4	350	6,000
Goldsmith Drlg Co	2	—	400	Natl 50	—	8,000
Holliman Drlg Co	1	gas	500	Unit U-15	900	7,500
	2	gas	350	Unit U-15	550	7,500
	3	gas	255	Unit U-15	600	7,500
Slats Honeymon Drlg Co	1	gas-btne	450	Natl 50-A	—	9,000
Jennings Drlg Co	5	btne-gas	450	Wlsn Giant	900	9,000
Kirkpatrick Oil Co	1	gas	300	Beth S-60	258	7,500
Nichols Drlg Co	1	gas-btne	450	Wlsn Giant	450	5,500
	4	gas-btne	450	Wlsn Giant	450	7,500
	5	gas-btne	1725	Natl 75-CA	1725	12,500
O'Neal-Garvin Drlg Co	1	dsl	300	Unit U-35	400	6,000
Parker Drlg Co	60	gas-elec	—	Natl L-34x10	2000	2,500
Perkins Bros Drlg Co	3	gas-btne	400	Beth S-60	370	7,500
Skipper Drlg Co	1	gas	325	Natl T-32	325	5,500
Viersen & Cochran	11	gas	1525	Natl 110	1530	18,500
Dick Wegener Drlg Contr	3	gas	350	Whind B-85	500	10,000
Texas County						
Drlg & Expl Co of Del Inc	24	gas	225	Wgnr Mrhse	400	5,000
Falcon Seaboard Drlg Co	16	gas-btne	425	Unit U-15	425	8,500
Garvey Drlg Co	9	dsl	175	Wlsn Giant	296	5,000
	18	dsl	300	Wlsn Roadair	450	6,000
Luke Grace Drlg Co	10	dsl-gas	600	Wlsn Gnt	600	8,500
Graham-Michaelis Drlg Co	4	dsl	500	Unit U-15	500	7,000
Holm Drlg Co	5	dsl	300	"Oilwell" 52 T	300	5,500
	6	dsl	750	Wlsn Roadair	600	8,500
Moran Bros Inc	2	gas	700	Emsco GA-500	750	10,000
Musgrove Petroleum Corp	2	dsl	495	Emsco 350	—	7,000
R W Rine Drlg Co	3	gas-btne	520	Unit U-15	600	7,500
Earl F Wakefield	4	gas-btne	750	Wlsn Gnt Rdair	750	9,500
Webster Drlg Co	7	gas-btne	700	Unit U-15	700	8,500
Tillman County						
Bolin Oil Co & D H Bolin	4	gas	350	Wlsn Gnt	500	7,500
Wagoner County						
Metzger Drlg Co	—	btne	90	Franks	—	2,500
Washington County						
Overby Drlg Co Inc	2	dsl-btne	250	Mayhew 2000	—	2,500
Washita County						
Nichols Drlg Co	77	gas-btne	1530	Natl 110	1530	18,000
Woods County						
Calvert Drlg Inc	21	dsl	350	Ideco H-35	260	6,500 4"
Dudley & Heath Drlg Co	7	dsl	265	Brwstr N-4	320	5,500
Gabbert-Jones Drlg Co	2	gas	450	Emsco 350	450	7,000
Unit Drlg Co	3	dsl	700	Natl 50-A	700	6,500
Woodward County						
Nichols Drlg Co	8	gas-btne	700	Natl 50-A	700	9,000
PENNSYLVANIA						
Berks County						
C S Garber & Sons Inc	—	gas-gaso	—	—	32	1,500
	—	gas-gaso	—	—	32	1,500
	—	gas-gaso	—	—	32	2,000
	23	dsl	—	Reich	—	1,200
	24	dsl	—	Ingersoll	135	130
Bucks County						
C S Garber & Sons Inc	25	dsl	—	Ingersoll	135	400
	26	dsl	—	Ingersoll	135	130
	27	dsl	—	Ingersoll 4	—	250
Clearfield County						
Delta Drlg Co	24	dsl	670	Emsco GC-500	500	8,500
	30	dsl	670	Emsco G-500	500	8,500
Fairman Drlg Co	1	gas-btne	500	Beth M-58	600	10,000
	2	gas-btne	500	"Oilwell" 66	600	9,000
Lohmann-Johnson Oil Co Inc	2	gas	500	"Oilwell" 76	750	10,000
Crawford County						
Union Rotary Corp	6	dsl	475	Natl 50	575	7,500
Indiana County						
Delta Drlg Co	34	gas-btne	800	Unit U-15	600	8,000
Lohmann-Johnson Oil Co Inc	9	gas	750	"Oilwell" 66	500	10,000
Somerset County						
Delta Drlg Co	10	dsl	560	Unit U-15	560	7,000
Westmoreland County						
Delta Drlg Co	33	gas-btne	624	Natl 50-A	450	7,000

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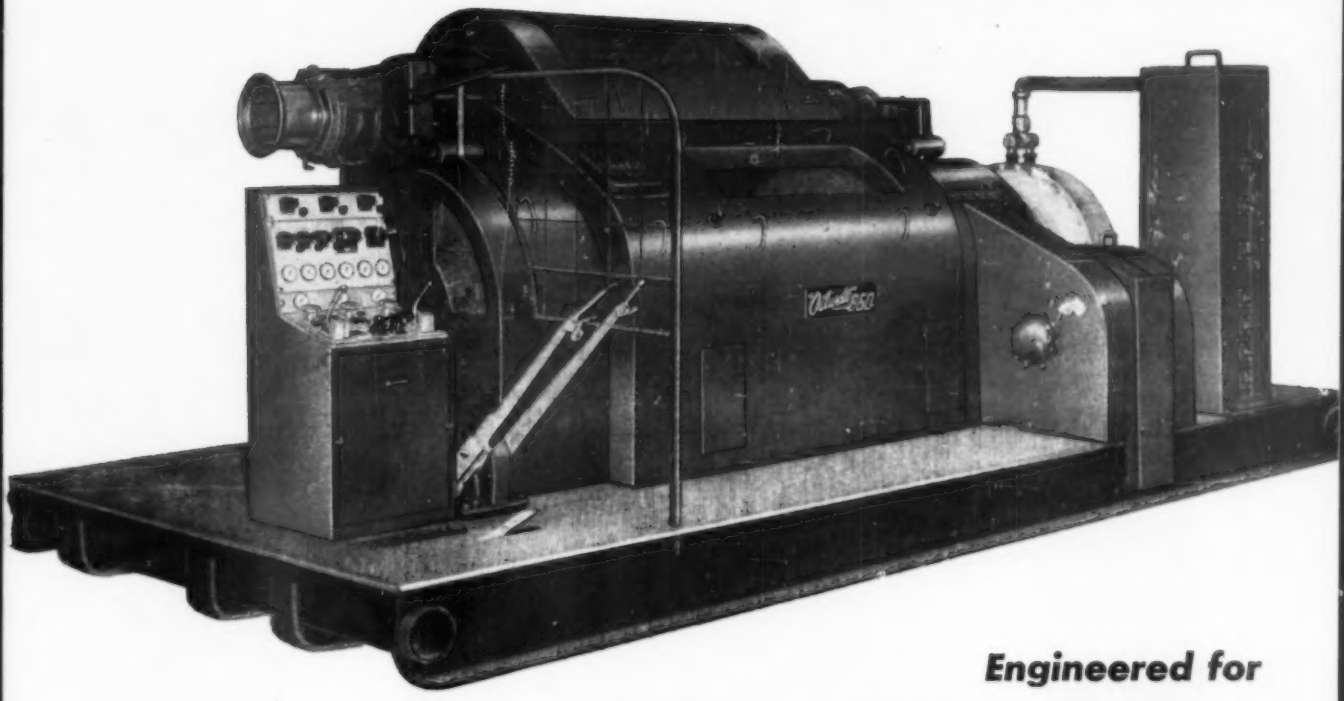
Before you buy ANYTHING in the 10,000 — 16,000-ft. drilling range

See this ALL-NEW "Oilwell" 860



Engineered for rugged service and low maintenance

"Oilwell's" NEW 860 DRAW WORKS introduces many engineering refinements that will increase operating efficiency and cut maintenance costs. For example:

- **The high drum clutch is gap-mounted and can be replaced without disturbing the hydromatic brake.**
- **All operations are air-controlled from a highly functional console and engines are compounded by a simplified push-button arrangement.**
- **Over-size openings provide maximum accessibility to working parts.**
- **The draw works' frame separates easily into two pieces for moving within 8'0" width; or the entire unit can be moved as a single package.**

There are more than 60 design features in this draw works which are either brand-new, or are improvements over present engineering practices. Contact your nearest "Oilwell" Representative for further information.

OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION

Executive Offices—DALLAS, TEXAS
Export Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Area Offices—
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CASPER, WYOMING.....COLUMBUS, O.
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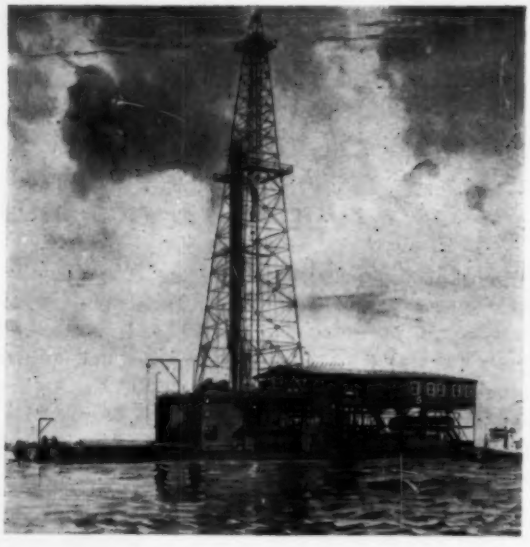
TULSA, OKLA.....LOS ANGELES, CALIF.

Oil Well Supply Division of USS United States Steel

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
TEXAS						
Anderson County						
Ace Drlg Co	3	gas	750	Natl 50-A	450	7,500
	4	gas	680	Emsco G-500	500	8,500
Robert M Bass Drlg Contr	5	gas-LPG	300	Wlsn Giant	300	5,500
Dale Mount Drlg Inc	109	stm	—	Emsco	—	14,000
Andrews County						
Arrow Drlg Co	24	dsl	1200	Emsco 1000	—	14,000
L E Bever Drlg Co	1	gas	225	Unit U-34	225	5,500
Big West Drlg Co	11	gas-btne	500	Unit U-20	900	14,000
C B Drlg Co	1	gas	450	Emsco GB-350	450	8,000
	4	gas	570	Emsco GB-350	570	8,000
Cactus Drlg Corp of Tex	1	gas-btne	1575	Natl 110	1575	15,000
	3	gas-btne	800	Natl 80-B	—	12,500
M J Delaney Co	27	gas-btne	500	Beth 450	850	11,000
Denver Drlg Corp	4	gas	440	Natl 50	440	8,000
Donnell Drlg Co	9	gas-btne	1400	Beth MC-950	1400	15,000
Empire Drlg Co	9	dsl	325	Wlsn Giant	550	7,500
Falcon Seaboard Drlg Co	Z-11	gas-btne	1000	Beth 950	1020	16,000
Lloyd R French Co	4	gas-btne	1200	Natl 75	900	12,500
Fryer & Hanson Drlg Co	4	gas-btne	1150	"Oilwell" 76	1200	12,000
	11	gas-btne	1200	Beth M-58	1200	12,000
Great Western Drlg Co	17	gas-gaso	765	Unit U-914B	1260	15,000
	27	gas-gaso	853	Unit U-914A	1125	15,000
O E Hall Drlg Co	3	gas	320	Unit U-15	700	8,000
Helmerich & Payne Inc	39	gas	1100	"Oilwell" 96	1300	14,000
	41	gas	1200	Natl 110	1500	15,000
Hissom Drlg Co	1	gas	600	Emsco 500	600	8,500
Johnson-Gadbois Drlg Co	2	gas	230	Natl T-20	—	5,500
Carl B King of Tex	1	gas-gaso	1000	Natl 100	1000	13,500
La Mance Drlg Co	3	btne	550	"Oilwell" 64	—	6,500
Llano Drlg Co	3	gas	—	"Oilwell" 96	975	14,000
	4	gas	—	Natl 75	1050	12,000
M & J Inc	7	gas	269	Unit U-34	—	5,000
B L McFarland Inc	5	gas	700	Brwstr N-75	—	12,000
	8	gas	700	Brwstr N-75	—	12,000
Milhoan Drlg Co	3	gas	900	Beth 450	—	10,000
Moran Oil Prod & Drlg Corp	1	gas	—	Unit U-15	800	8,500
Parker Drlg Co	4	gas	—	Natl L-100	1400	14,000
	16	gas	—	Natl L-100	1400	14,000
	28	gas	—	Natl L-50	700	9,000
	47	gas	—	Natl L-100	1400	14,000
Penrod Drlg Co	1	gas-btne	—	—	1800	15,000
Fred Pool Drlg Co	1	gas	580	Unit U-15	600	7,500
Robinson Brothers Drlg Co	1	gas	800	Brwstr N-75	800	10,000
A W Thompson Inc	6	gas	600	Beth 450	1050	11,000
Western Drlg Co Inc	18	btne	450	Crdwll O	225	8,000
Aransas County						
Bilbo-Redding Drlg Co Inc	Bge 6	dsl	1050	"Oilwell" 76	—	12,500
Camden Drlg Co	Bge 2	dsl	600	Natl T-32	300	7,500
Archer County						
Ayers and Burch	2	btne	145	Wlkr-Neer	—	3,000
Cooper Drlg Co	5	gas-btne	600	Wlsn Giant	600	7,500
R W Darden Drlg Co	1	gas	145	Wichtex R-3	—	3,000
T V Gorman Drlg Contr	1	dsl	200	Wichtex R-3	200	3,000
Gray Drlg Co	1	gas-gaso	220	Wlsn Gnt Roadair	450	5,500
Louis Pitcock Drlg Co	7	gas-btne	225	Beth S-45	3250	4,000/3½"
Atascosa County						
Buzzini Drlg Co	7	gas-btne	950	Wlsn Atlas	930	11,000
	8	gas-btne	1750	Wlsn Titan	1210	13,000
Steen Drlg Co	4	gas-btne	1625	Ideco 1050	1430	16,000
Austin County						
Buzzini Drlg Co	5	gas-btne	900	Wlsn Gnt	712	10,000
Bandera County						
Pool & Gerlich Drlg	D-1	gas	260	Unit U-34	300	5,000
Baylor County						
Harold Shappell Drlg Co	1	btne	245	Wichtex	145	2,800
Tibbits Drlg Co	4	gas	350	Wlsn Gnt	525	7,500
Bee County						
Fitzpatrick Drlg Co	3	dsl	775	Brwstr N-7	700	8,500
Flournoy Drlg Co	2	gas-btne	300	Wlsn Giant	185	4,500
C G Glasscock Drlg Co	7	gas	800	Unit U-15	—	9,000
J E Hillier	2	dsl	400	Ideco H-40	400	7,000
Bexar County						
Walters Drlg Co Inc	11	gas	150	Mayhew 1000	150	600/2½"

GULF COAST DRILLING SPECIALISTS

J. F. Burdett
President



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OPERATING SIX MODERN RIGS *to Meet Your Needs*
ON LAND AND WATER IN THE GULF COAST AREA

HARRY L. EDWARDS DRILLING COMPANY

P. O. Box 6825 Phone GY 4-2561 Houston 5, Texas

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Borden County						
Catcus Drlg Corp of Tex	6	gas-btne	300	Urit U-15	—	8,500
Kerr-McGee Oil Ind Inc	3	gas	800	Natl 75	832	11,500
Empire Drlg Co	2	gas	500	Brwstr N-7	750	5,500
	8	gas	500	Unit U-15	675	8,500
Falcon Seaboard Drlg Co	21	gas-btne	600	Unit U-15	600	8,500
John Grappe Drlg Co	3	gas-btne	1000	L C Moore	900	13,000
Chas E Long Jr Inc	2	dsl	250	Emsco GA-500	520	10,000/3½"
Rheay & Reynolds Drlg Co	3	gas	400	Unit U-15	1200	6,500
	5	gas	350	Natl 75	1200	7,000
Triad Drlg Co	5	gas-btne	650	Beth 450	650	12,000
Brazoria County						
Bay City Drlg Co Inc	1	gas-btne	430	"Oilwell" 52-T	430	6,500
Clegg & Hunt	7	dsl	—	Natl 75	880	11,000
C J Foster Drlg Co Inc	2	gas-LPG	—	Brwstr N-75	834	11,000
	3A	stm	—	Emsco EB-54-4	1000+	18,000
	9	gas-LPG	1	Wisn Gnt	412	8,000
Mac Drlg Co	12	stm	500	Natl 23-9-FED	1000+	20,000
Robinson-Wehmeyer Drlg Co	1	gas-btne	450	Unit U-34	225	6,000
Brooks County						
Falco Drlg Co	2	gas	600	Wisn Giant	650	8,000
Harkins & Co	6	gas-gaso	675	Unit U-15	675	9,500
Stice Drlg Co	1	btne-gas	496	Unit U-15	—	7,500
Caldwell County						
Travis Drlrs Inc	2	gas-btne	250	Brwstr H-3	165	3,000
Calhoun County						
Bilbo-Redding Drlg Co Inc	5	gas-LPG	900	Beth 450	—	11,000
Layton Brown Drlg Co	Bge 2	dsl	—	—	800	10,000
	3	stm	—	—	1050	10,000
C G Glasscock Drlg Co	8	dsl	1200	Natl 75	—	12,000
Harkins & Co	3	gas-gaso	850	Unit U-15	850	10,000
Neal Drlg Co	1	gas	750	Emsco G-500	560	9,500
Turnbull & Zoch Drlg Co	5	gas-btne	850	Unit U-15	850	9,500
Callahan County						
Hack Drlg Co	2	btne	—	Crdwll S	161	4,500
Low Drlg Co	2	btne	—	Wilson	145	3,00
Woodson Prod Co	2	gas	600	Unit U-15	900	8,500
Cameron County						
Fitzpatrick Drlg Co	4	gas	1050	Beth Tornado	1000	13,000
Cass County						
Butler-Johnson Inc	2	gas-btne	450	Brwstr N-55	450	8,000
	3	gas-btne	400	Brwstr N-45	400	7,000
B F Edington Drlg Co Inc	104	gas-gaso	150	Joy	250	2,500/2⅞"
Gilger Drlg Co	2	gas-btne	600	Beth 400	400	7,500
Chambers County						
Bilbo-Redding Drlg Co Inc	Bge 7	dsl	550	"Oilwell" 64-B	—	7,500
Brewster-Bartle Drlg Co Inc	4	gas	—	"Oilwell" 76	—	11,000
	10	dsl	—	"Oilwell" 76	—	11,000
Clegg & Hunt	2	stm	—	Emsco H-54	—	11,000
Columbia Drlg Co	Bge 1	dsl	800	"Oilwell" 76	750	12,000
Continental Drlg Co	7	dsl	1200	Emsco GB-800	1200	14,000
Harry L Edwards Drlg Co	Bge 10	dsl	—	Ideco PR-1050	—	16,000
Holmes Drlg Co	1	gas-gaso	—	Beth ML-450	1000	11,000
Meadows & Walker Drlg Co	2	stm	1000	Alco BIW 12	1000+	12,000
Meredith & Co	1	gas-gaso-btne	—	Emsco G-500	680	9,500
Howard Parker Co	5	gas-btne	600	Unit U-15	900	10,500
Cherokee County						
Gibson Drlg Co	2	gas-btne	226	Wisn Mogul 42	145	5,000
	5	gas-btne	275	Wisn Giant	275	6,000
Johnson Drlg Co	2	dsl	300	Spencer	250	6,000/3½"
LeCuno Oil Corp	4	gas-LPG	1050	Wisn Titan	1050	13,500
Clay County						
H O Grace Drlg Co	1	btne	—	—	—	6,000
	4	btne	—	—		7,500
Jack Grace Drlg Co	19	gas-btne	255	Wisn Giant	350	5,000
Graytex Drlg Co	1	gas	325	Natl T-32	350	6,500
B M Hester	1	btne	325	Natl T-20	200	6,000
Jennings Drlg Co	6	btne-gas	350	Brwstr	350	6,000
Lin-Mour Drlg Co	1	gas	315	Wisn Mogul	400	4,600
E W Moran Drlg Co	5	gas	370	Natl 50	650	7,500
Cochran County						
Hissom Drlg Co	3	gas	450	Beth S-60	450	6,500
Price-Sitton Drlg Co	1	btne	270	Wisn Giant	270	5,400
Western Drlg Co Inc	9	btne	500	—	500	5,000
	11	dsl	288	Emsco 350	375	6,500
	13	dsl	600	Crdwll O	325	9,000
	14	dsl	375	Emsco 500	375	8,000
	15	dsl	375	Emsco 500	375	8,000
Coke County						
Cactus Drlg Corp of Tex	10	gas-btne	700	Beth M-58	700	9,000
Dual Drlg Co	2	dsl	400	Beth S-55	400	6,500
	5	gas	400	Emsco GA-500	400	7,000
Empire Drlg Co	5	gas	325	Unit U-15	550	8,000
General Geophysical Co	31	dsl	—	—	500	7,500
Tucker Drlg Co	5	gas	620	Crdwll O	620	9,500
Coleman County						
Burger Drlg Co	1	gas	225	Wisn Mogul	185	4,000
Maxwell Drlg Co	1	btne-gas	220	Brwstr N-4	220	5,500/3½"
Tex-Mex Drlg Co	9	gas	400	Emsco 250	450	5,500
Travis Drlrs Inc	1	gas-btne	325	Natl T-20	245	5,000
Colorado County						
Bilbo-Redding Drlg Co Inc	3	stm	1050	Emsco UBLS 54	1000+	12,500
Meadows & Walker Drlg Co	1	gas-btne	875	"Oilwell" 66	828	10,500
Chet Whaley Well Serv Co	1	gas-gaso-btne	225	Wisn Gnt	225	5,500/3½"
Concho County						
Tucker Drlg Co	4	dsl	610	Beth J-55	—	9,500
Wes-Tex Drlg Co	2	btne	244	Brwstr N-4	280	5,500
Cooke County						
Brown & Martin Drlg Co	1	btne	230	Wisn Giant	215	5,500
	2	btne	150	Wilson	105	1,500
Felderhoff Bros Drlg Co	1	dsl	260	Wisn Mogul	220	4,700
Roy Guffey Drlg Co	5	gas-btne	430	Unit U-34	260	5,500
Russell & Russell Drlg & Prod Co	1	gas-gaso-btne	275	Wisn Gnt	180	4,500
	3	—	350	Wisn Mogul	350	5,000
Cottle County						
West Central Drlg Co	5	gas-btne	325	Unit U-15	600	7,500
Crane County						
B B M Drlg Co	10	gas-btne	200	Emsco GA-500	450	7,000/3½"
Henry Black Drlg Co Inc	3	gas	350	Natl 50	450	8,500
Blount Drlg Corp	4	dsl	275	Brwstr N-4	275	5,500
Brantly Drlg Co Inc	2	gas	975	Emsco 800	1000	14,000
Delta Drlg Co	4	gas-btne	800	Natl 100	800	12,000
Gardner Bros Drlg Co Inc	6	gas-btne	500	Natl 75	700	10,500
Great Western Drlg Co	38	gas-gaso	320	Unit U-15	675	7,500
Guadalupe Drlg Co	1	gas-btne	700	Ideco M-1000	—	10,000
Helmerich & Payne Inc	42	gas	970	Natl 100	1000	13,000
Johnn Drlg Co	7	gas	185	Brwstr N-4	300	5,500
Laughlin-Porter Drlg Co Inc	2	gas	—	Unit U-15	—	7,500
	4	gas	1650	Ideco 1350	—	14,000
Leatherwood Drlg Co	1	gas	600	Ideco 750	—	10,000
Lee Drlg Co	1	gas-gaso	700	Natl 50	—	8,000
	2	gas-gaso	700	Natl 50	—	8,000
	7	gas-gaso	440	Beth S-55	—	6,000
McDaniel & Beecherl Drlg Co	10	gas-gaso	—	"Oilwell" 66	—	10,000
Parker Drlg Co	39	gas	—	Natl L-100	1400	14,000
	59	gas	—	Natl 75	1000	11,000
Rowan Drlg Co Inc	22	gas-btne	600	Natl 50	766	7,000
B B Smith Inc	1	gas	600	Brwstr N-4	300	6,000/3½"
	2	gas	600	Unit U-15	450	7,000
Western Serv Drlg Co Inc	2	gas-btne	600	Natl 50-A	700	8,000
	7	gas-btne	600	Natl 50	700	7,000
Crockett County						
Bolin Oil Co & D H Bolin	1	gas	225	Natl T-12	145	3,500
Sam E Crump Drlg Co	1	gas	—	Unit U-15	650	8,500
Durham Drlg Co Inc	2	gas	500	Unit U-15	675	9,000
Frank Frawley Drlg Co	4	gas	—	Unit U-40	850	10,000
Laughlin-Porter Drlg Co Inc	8	gas	—	Natl 75	700	900
Frank Raiborn Drlg Co	1	gas	225	Wisn Mogul	186	4,000
A W Thompson Inc	8	gas	450	Beth 58	750	10,000
Crosby County						
Smith & Breyer	4	gas	530	Frnks	530	9,500
Culberson County						
Leatherwood Drlg Co	3	dsl	220	Natl T-20	—	6,000
McQueen & Stout Drlg Co	9	LPG	225	Crdwll RL	185	4,500
Dallam County						
Drlg & Expl Co of Del Inc	25	gas	225	Frnks137/33DTDX	400	5,000
Schafer Drlg Co	9	gas-gaso	300	Ideco H-35	300	7,500
Dawson County						
Brantly Drlg Co Inc	8	gas	675	Beth 450	870	11,500
Coroco Drlg Co	6	gas-gaso	400	"Oilwell" 66	500	9,000
Frank Frawley Drlg Co	3	gas	—	Natl 100	1050	13,000
Milhoan Drlg Co	7	gas	600	"Oilwell" 76	—	8,000
Dale Mount Drlg Inc	101	gas	850	Emsco	570	9,000
	115	gas	1200	Emsco	1200	12,000
Reed Drlg Co	33	gaso	50	Mayhew	80	1,500/2⅛"
	37	btne	50	Mayhew	80	1,500/2⅛"
Deaf Smith County						
Edgar Davis Drlg Co	12	gas-btne	650	Wisn Giant	675	10,000
La Mance Drlg Co	4	btne	1050	Wisn Titan	—	13,000
Webster Drlg Co	3	gas-btne	750	Wisn Atlas	750	10,000
Denton County						
Holliman Drlg Co	6	gas	750	Wisn Atlas	950	10,000
De Witt County						
Holmes Drlg Co	6	gas-gaso	—	Beth MC-450	700	10,000
Dickens County						
St John Drlg Co	2	gas	300	Natl 50	450	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Dimmit County						
Sutton Drlg Co	1	dsl	—	—	225	3,500
	3	dsl	300	Brwstr N-4	350	6,500
	6	dsl	121	Alamo	225	5,000/2⅞"
Duval County						
Chiles Drlg Co	3	dsl	400	Ideco H-40-D	460	7,500
Davis & Bates Inc	1	dsl	375	Brwstr N-4	350	7,000
Del Mar Drlg Co	2	dsl	400	Natl 50	762	8,000
Field Drlg Co	1	dsl	1040	Natl 50-A	520	9,500
Flournoy Drlg Co	3	gas-btne	353	Brwstr N-45	320	6,500
General Well Drlg Inc	3	gas-btne	425	Beth	183	5,000
	8	gas-btne	500	Brwstr N-4	185	5,000
Rhodes & Hicks Drlg Corp	1	gas-btne	370	Frnks 137	200	5,500
V & C Drlg Co	3	dsl	700	Emsco 500	700	8,000
Eastland County						
Irish Drlg Co Inc	3	btne	285	Wisn Mogul	—	4,000
	4	btne	360	Wichtex R-5	—	4,000
Reagan Drlg Co	1	btne	225	Wisn Giant	187	5,500/3½"
Ector County						
Robert M Bass Drlg Contr	3	gas-LPG	400	Wisn Gnt Rdair	600	8,500
Beckman Inc	1 (wo)	gas	185	Unit U-15	350	6,000
	2 (wo)	gas	185	Beth S-50	185	3,500
Blount Drlg Corp	2	gas-btne	675	Unit U-15	675	8,000
Brantly Drlg Co Inc	1	gas	365	Emsco 500	500	9,000
	4	gas	375	Beth S-55	480	6,500
Choya Drlg Co Inc	3	gas-btne	900	Beth MC-650	900	12,000
	5	gas-btne	460	Emsco GB-350	460	6,500
Coroco Drlg Co	1	gas-gaso	500	Beth 650	650	12,500
	4	gas-gaso	650	Wisn Spr Titan	900	15,000
Davidson Drlg Co Inc	C	btne	600	Emsco GC-500	660	8,500
M J Delaney Co	26	stm	—	Natl T-38	—	15,000
	30	gas-btne	500	Beth 1013	1200	15,000
Delta Drlg Co	36	gas-btne	900	Wisn Titan	900	15,000
Denver Drlg Corp	1	gas	370	Crdwll EC	370	5,000
Donnell Drlg Co	6	gas-btne	975	Beth MC-450	975	10,000
	10	gas-btne	650	Beth M-58	650	10,000
	14	btne	—	Ideco H-40	370	4,000
Dual Drlg Co	6	gas	250	Emsco GA-250-T	300	5,000
Eastland Drlg Co	1	gas	—	—	750	10,000
	2	gas	—	—	540	7,500
	4	gas	—	—	190	4,500
Exploration Drlg Co	7	gas	1200	Natl 80-B	1350	13,000
	14	gas	800	Natl 75-CA	900	11,000
Lloyd R French Co	1	gas-btne	765	Natl 50	600	9,000
	2	gas-btne	675	Unit U-15	600	7,500
	3	gas-btne	650	Natl 50	600	7,500
Gardner Bros Drlg Co Inc	5	gas-btne	500	Natl 75	675	9,000
	8	gas-btne	500	Natl 50	675	7,000
	10	gas-btne	750	Natl 100	1050	12,500
	15	gas-btne	1000	"Oilwell" 96	1500	16,000
	16	gas-btne	1000	Natl 125	1400	15,000
	18	gas-btne	400	Natl 50	575	7,000
Highland Drlg Co	1	gas	—	Natl 50	550	8,200
Johnn Drlg Co	4	gas	375	Unit U-15	600	8,500
	9	gas	375	Brwstr N-45	400	7,000
Carl B King Drlg Co of Tex	5	gas-gaso	1000	Natl 100	1000	13,500
La Mance Drlg Co	5	btne	550	Unit U-15	550	7,500
Laughlin-Porter Drlg Co Inc	5	dsl	1080	Natl 23-9 FEB	—	12,000
Lee Drlg Co	5	gas-gaso	1050	Natl 100	—	13,000
	6	gas-gaso	1050	"Oilwell" 76	—	13,000
Lowe Drlg Co	3	gas	1000	Natl 100	—	12,500
Parker Drlg Co	32	gas	—	Natl 50	700	9,000
	41	gas	—	Natl L-100	1400	14,000
	43	gas	—	"Oilwell" 96	1400	15,000
	54	gas	—	Natl L-125	1400	20,000
	58	gas	—	Natl L-100	1400	14,000
Rowan Drlg Co Inc	16	gas-btne	504	Natl 50	660	7,000
Schoenfeld-Hunter-Kitch Drlg Co	1	LPG-gas	—	Beth 650	1000	14,000
	10	LPG-gas	300	Beth Twister	300	7,500
Darrell W Smith Co	1	dsl	470	Crdwll D	470	6,000
A W Thompson Inc	1	gas	1500	Emsco A-1500	1800	18,000
Triad Drlg Co	1	gas-btne	500	Natl 50	500	7,000
Goal Tullous & Co	1	gas	500	Emsco J-750	1050	10,000
	2	gas	600	Emsco J-750	1050	10,000
Warton Drlg Co	2	gas	600	Natl 50	700	8,500
Fayette County						
Hamman Oil & Ref Co	6	dsl	250	Brwstr N-4	310	6,500
Fisher County						
General Geophysical Co	32	btne	—	—	500	7,500
Roy Guffey Drlg Co	2	gas-btne	520	Unit U-15	520	7,500
Norwood Drlg Co	1	gas-gaso	350	Wisn Gnt Rdair	600	8,500
A B See Drlg Co Inc	1	gas	400	Natl T-20	250	5,000
Wes-Tex Drlg Co	3	btne	225	Crdwll B	326	6,500
	5	btne	276	Natl 50	588	8,500
Foard County						
E W Moran Drlg Co	2	gas	500	Wisn Gnt	650	7,500
Fort Bend County						
C J Foster Drlg Co Inc	6	gas-LPG	—	Frnks H-37	260	6,000
Freestone County						
Bay City Drlg Co Inc	3	gas-btne	560	"Oilwell" 66	560	10,800
	4	gas-btne	420	Brwstr N-45	420	7,500
B G Byars Power Drlg Co	3	dsl	400	Emsco G-300	300	5,500
M J Delaney Co	24	gas-btne	500	Beth M-58	600	9,500
	31	gas-btne	450	Wisn Gnt Rdair	650	7,000
Frio County						
Longhorn Drlg Co	6	gas-btne	500	"Oilwell" 76	1185	14,000
Milam Drlg Co	1	gas	500	Emsco G-500	500	7,500
Pegg Bros Drlg Co	1	gas-btne	145	Brwstr	145	4,500/3½"
Gaines County						
B B M Drlg Co	2	gas-btne	1100	Emsco GB-800	1050	14,000/4"
	6	gas-btne	400	Emsco GB-500	650	10,000/3½"
Henry Black Drlg Co Inc	6	gas	400	Unit U-15	500	8,500
Brantly Drlg Co Inc	5	gas	375	Emsco 250	250	4,000
Cactus Drlg Corp of Tex	5	gas-btne	700	Natl 75	700	10,000
M J Delaney Co	19	gas-btne	600	Emsco J-1250	1200	15,000
	29	gas-btne	500	Beth 450	750	11,000
Drlg & Expl Co of Del Inc	14	gas-elec	1100	Natl 34-10	1000	17,000
Dual Drlg Co	4	gas	950	Beth 450	1100	13,000
Great Western Drlg Co	35	dsl	300	Unit U-15	760	7,500
O E Hall Drlg Co	2	gas	320	Unit U-15	700	8,000
Hissom Drlg Co	4	gas	400	Unit U-34	350	5,000
Johnn Drlg Co	3	gas	650	Wisn Atlas	900	10,000
Laughlin-Porter Drlg Co Inc	7	gas	400	Wisn Torcair	—	5,000
Lowe Drlg Co	2	gas	750	Natl 75	—	10,000
	5	gas	750	Natl 75	—	10,000
Moran Oil Prod & Drlg Corp	2	gas	—	Natl 75	750	10,000
Dale Mount Drlg Inc	112	gas	1200	Emsco	1200	12,000
Texas R F O Inc	4	gas	675	Unit U-15	675	8,500
Triad Drlg Co	4	gas-btne	400	Unit U-34	400	6,500
Galveston County						
Edwards & Bissett Inc	3	gas-btne	1100	Brwstr N-75	800	10,500
C J Foster Drlg Co Inc	4	gas-LPG	—	Prtble CT-5	550	8,500
Howard Parker Co	1	gas-btne	600	Crdwll D	500	8,000
Penrod Drlg Co	18	stm	—	—	—	15,000
Garza County						
Alan Drlg Co	1	gas	550	Wisn Giant	850	8,000
McCutchen & Graham	1	btne	425	Wisn Spr Atlas	650	11,000
Norwood Drlg Co	2	gas-gaso	600	Wisn Atlas	900	10,500
Smith & Breyer	2	gaso	—	Cooper	—	3,000
	3	dsl-btne	355	Spencer	355	4,250
Texas R F O Inc	3	dsl-gas	250	Emsco GA-250	290	5,000
Warton Drlg Co	4	gas	700	Emsco J-750	1000	12,000
Western Drlg Co Inc	17	btne	440	Crdwll L	145	4,000
Wes-Tex Drlg Co	6	btne	675	Unit U-15	675	9,500
Glasscock County						
A W Thompson Inc	7	gas	650	Beth 450	1050	11,000
Goliad County						
Harkins & Co	4	gas-gaso	700	Wisn Giant	700	9,500
	7	dsl	600	Unit U-15	600	8,500
Sutton Drlg Co	7	dsl	121	Alamo	225	5,000
Gonzales County						
Adkins Drlg Co	1	gas-gaso	600	Crdwll O	825	10,000
Gray County						
Beckman Inc	12 (wo)	gas	150	MIW P-42	175	10,000/2⅞"
Cree Drlg Co Inc	2	gas-btne	255	Unit U-10	360	4,500
Murphy & McKernan	1	dsl	390	Unit U-15	375	7,500
Schafer Drlg Co	6	gas-gaso	200	Unit U-34	200	5,000
Service Drlg Co	2	LPG	300	Unit U-34	180	4,500
	6	dsl	320	Brwstr N-4	210	4,500
Grayson County						
Jack Grace Drlg Co	12	gas-btne	625	Wisn Atlas	1200	10,000
Luke Grace Drlg Co	18	dsl-gas	600	Unit U-15	600	9,000
Johnn Drlg Co	8	gas	500	Brwstr N-75	700	10,000
E W Moran Drlg Co	3	dsl	285	Wisn Giant	650	7,500
Nichols Drlg Co	6	gas-btne	1050	Wisn Titan	1050	15,000
Penrod Drlg Co	21	dsl	—	—	385	6,000
Gregg County						
B G Byars Power Drlg Co	2	gas-btne	1145	Emsco GA-500	750	10,500
Delta Drlg Co	7	stm	750	Emsco UB-54	1200	12,000
Johnson Drlg & Serv Co	2	dsl	225	Beth Twister	300	6,500
South States Drlg Co	3	dsl	330	Emsco GB-350	520	8,000/4"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Hansford County						
Arrow Drlg Co	9	gas	560	Emsco 500	—	8,000
	11	dsl	595	Emsco 500	—	8,000
	20	gas	460	Emsco 350	—	7,000
Baker & Taylor Drlg Co	1	dsl	800	Unit U-15	800	8,500
Jack Grace Drlg Co	16	gas-btne	1020	Wisn Titan	1200	12,500
Helmerich & Payne Inc	7	gas	500	Emsco GB-500-82	700	9,000
Moran Bros Inc	1	gas	1050	Wisn Titan	1150	14,000
	6	gas	700	Wisn Giant	750	10,000
Rowan Drlg Co Inc	10	gas-btne	1020	Beth 450	766	9,000
Hardin County						
Bilbo-Redding Drlg Co Inc	1	dsl	750	Whind 65	550	9,500
CBS Workover Co	1	gas-btne	300	Ideco H-30D	215	4,500
	2	gas-btne	145	Crdwll K	145	2,500
Clegg & Hunt	9	btne-gas	—	Natl 50-A	—	9,800
Coon-Murphy Drlg Co	1	gas	675	Frnks 137TD	340	6,700/3½"
Owen Drlg Co	6	gas	555	Unit U-15	—	8,000
	8	dsl	1040	Natl 50	1040	9,500
Harris County						
Appell Petroleum Corp	3	gas-gaso	510	Brwstr N-4	225	5,500
Big "6" Drlg Co	3	gas-btne	500	Crdwll Tlrg'	500	6,000
Columbia Drlg Co	5	dsl	400	Unit U-15	—	8,500
Comet Drlg Co	3	stm	900	Ideco Jr Gnt	—	10,000
Edwards & Bissett Inc	6	gas-btne	600	Ideco H-40D	500	7,000
C J Foster Drlg Co Inc	8	gas-LPG	—	"Oilwell" 64-A	366	8,000
Justrite Serv Co	1	gas	185	Frnks TD-65	185	4,000
Mac Drlg Co	7	stm	500	Natl 34-26	5000	10,000
Miller Bros & Bowling	2	gas-btne	800	Emsco G-450	—	8,500
Howard Parker Co	4	gas-btne	300	Crdwll D	750	9,500
Taylor Expl Co Inc	3	gaso	—	Mayhew	75	1,000
Triton Drlg Co Inc	8	gas	800	Unit U-15	800	10,000/4"
Carnes W Weaver Drlg Co	5	gas-btne	465	Unit U-34	—	5,000
Harrison County						
Barnwell Drlg Co Inc	11	dsl	800	Wisn Roadair	600	12,000
	45	dsl	800	Brwstr N-45	380	8,000
Carter-Jones Drlg Co	8	gas-btne	—	—	500	7,500
Gibson Drlg Co	3	gas-btne	300	Wisn Giant	275	6,000
Jackson Oil Co	1	dsl	330	Crdwll O	520	6,500
LeCuno Oil Corp	1	gas-LPG	705	Wisn Gnt Rdr	705	9,250
	5	dsl	250	Wisn Mogul 42	250	6,500
Penrod Drlg Co	7	dsl	—	—	730	9,000
Tex-Mex Drlg Co	8	stm	—	—	1000+	9,000
J C Trahan Drlg Contr Inc	1	gas	740	Unit U-15	600	9,500
Hartley County						
Wagner & Wyant Drlg Co Inc	2	dsl	300	Unit U-15	675	8,000
Haskell County						
Ace Drlg Co	1	gas	680	Emsco G-500	500	8,000
B A Duffy Drlg Co	1	dsl	675	Frnks 3172	675	7,500/3½"
McCutchen & Graham	2	btne	255	Unit U-15	570	7,500
Hidalgo County						
Clark Fuel Prod Co	2	dsl	740	Wisn Gnt	520	8,500
Field Drlg Co	2	dsl	1000	Unit U-15	750	10,000
Fitzpatrick Drlg Co	1	stm	800+	Ideco	1000+	12,000
	2	gas	950	Unit U-40	900	10,000
Harkins & Co	1	gas-gaso	555	Unit U-15	555	8,500
Harrell Drlg Co	3	gas	700	Unit U-15	700	8,500
Holmes Drlg Co	3	gas-gaso	—	Natl 110	1500	16,000
Hugh Kirkpatrick Inc	1	gas	696	TIW 5	712	8,000
	2	gas	1080	Natl 55-A	600	10,000
Southland Drlg Co	2	gas-btne	700	Brwstr N-55	700	9,000/5"
Viking Drlg Co	2	dsl	475	Natl 50-A	500	8,500
John W Voss Drlg Co Inc	1	pwr	625	Brwstr N-75	852	10,000
Hockley County						
B B M Drlg Co	5	gas-btne	450	Emsco J-750	650	12,000/3½
Great Western Drlg Co	37	gas-gaso	700	Unit U-40	1200	10,000
Midland Drlg Co	1	gas-btne	600	Unit U-15	600	8,000
Robinson Brothers Drlg Co	2	gas	800	Brwstr N-75	800	10,000
Howard County						
Bolin Oil Co & D H Bolin	7	gas	225	Beth S-50	185	4,500
Brown & Scarber Drlg Co	2	gas-btne	325	Wisn Gnt	265	5,000
John Grappe Drlg Co	1	gas-btne	520	Beth	—	8,500
Milestone Drlg Co	100	dsl	550	Ideco H-525	600	7,500
Robinson Drlg Co (Colo. City)	2	btne	600	Unit U-15	600	9,000/3½"
C D Turner Drlg Co	2	btne	180	Wisn Mogul	180	4,500
Urice Drlg Co	3	gas-btne	700	Emsco GB-500	700	9,000
Hutchinson County						
Schafer Drlg Co	7	gas-gaso	200	Ideco H-35	200	5,000
Service Drlg Co	10	LPG	250	Unit U-34	150	4,000
Irion County						
Henson Drlg Co	2	btne	540	Unit U-15	540	7,500
	4	btne	825	Unit U-15	825	7,500
Pool & Gerlich Drlg	D-3	gas	350	Emsco G-250	300	6,000
Tucker Drlg Co	2	gas	425	Brwstr N-4	—	6,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Jack County						
American Drlg Corp	1	gas-btne	450	Emsco 500	450	6,000
Jess P Cross Drlg Contr	1	gas-btne	250	Wisn Mogul	230	4,500/3½"
Jack Grace Drlg Co	20	gas-btne	370	Wisn Giant	700	8,000
Luke Grace Drlg Co	4	dsl-gas	300	Wisn S E Gnt	300	5,000
Leatherwood Drlg Co	4	gas	450	Crdwll	450	6,000
Llano Drlg Co	8	dsl	300	Ideco H-30	300	4,500
W B Omohundro	4	btne	450	Wisn Atlas	—	6,000
Ward Drlg Co	2	btne	300	Wisn Giant	600	5,000
Jackson County						
Harry T Bryant Drlg Co Ltd	2	gas-btne	700	TIW C-T5	600	8,000
Al Buchanan Drlg Co	1	gas-gaso-LPG	1000	Ideco 10,000	561	9,000
Columbia Drlg Co	2	gas	600	Natl 75	—	11,500
Field Drlg Co	4	dsl	520	Beth Breeze	260	6,500
Mac Drlg Co	5	gas-gaso-btne	275	Beth S-45	450	5,000
McKenzie Drlg Co	5	gas	440	Vic Skytop	400	7,000/3½"
Howard Parker	2	gas-btne	500	Crdwll D	750	9,500
Chet Whaley Well Serv Co	2	gas-gaso-btne	225	Wisn Giant	275	5,000/3½"
Jefferson County						
Harry T Bryant Drlg Co Ltd	3	gas-btne	700	TIW 5	600	8,000
	4	gas-btne	900	Natl 75	900	12,000
Clegg & Hunt	3	dsl	—	Wisn Titan 56	800	11,500
	10	btne-gas	—	Natl 50-A	—	10,000
Henderson Drlg Corp	4	gas-btne	1000	Natl B-80	1000	12,500
	5	gas-btne	800	Natl 55	800	11,000
Meredith & Co	3	gas-gaso-btne	—	"Oilwell" 96	1150	13,000
Penrod Drlg Co	Rge 40	dsl	—	—	1095	12,000
Timberland Expl Co	2	gas-btne	1100	"Oilwell" 76	1200	12,500
Jim Hogg County						
Clark Fuel Prod Co	1	dsl	260	Natl T-8-S	140	2,500
Jim Wells County						
Chiles Drlg Co	1	dsl	600	Brwstr N-7	600	8,500
Falco Drlg Co	1	gas	750	Brwstr N-45	400	6,500
General Well Drlg Inc	7	dsl	650	Crdwll	300	6,500
Rhodes & Hicks Drlg Corp	2	btne	370	Natl T-32	370	6,500
Turnbull & Zoch Drlg Co	7	gas-btne	630	Ideco Rambler	630	10,000/3½"
Jones County						
Black Drlg Co	1	dsl	275	Frnks	250	4,000/3½"
Dixon Drlg Co	4	dsl-gas	200	Natl T-12	200	4,000
Drill Well Oil Co	1	btne	185	Wisn Super	—	4,000
Fryer & Hanson Drlg Co	10	gas-btne	225	Unit U-34	275	4,500
Hack Drlg Co	1	btne	—	Unit U-15	412	8,500
Johnson-Gadbois Drlg Co	5	gas	410	Wisn Mogul	—	4,000
Lauderdale & Straughan Drlg Co	2	LPG	570	Beth S-55	—	7,000
Low Drlg Co	1	btne	—	Emsco	290	7,000
J E Miller Drlg Contr	2	btne	200	Natl T-12	165	4,000
Moore & Moore Drlg Co	5	btne	175	Unit U-34	210	5,000
Sojourner Drlg Corp	5	btne	225	Natl T-8-S	—	3,250
Kaufman County						
Walters Drlg Co Inc	14	gas	—	Mayhew 1000	150	400/2⅛"
K y County						
Del Mar Drlg Co	1	stm	800+	Alco BIW 12	1000	11,000
C G Glasscock Drlg Co	5	dsl	1060	Natl 75	—	12,000
Layton Brown Drlg Co	Rge 4	dsl	1850	"Oilwell" 96	1100	16,000
Stewart & Gouger Drlg Co	5	pwr	1000	Ideco 7-11	1000	12,000
Kent County						
Drillers Inc	U-15	dsl	—	Unit U-15	600	7,200
Dugger & Herring Drlg Co	2	gas-btne	500	Unit U-15	600	8,500
Warner & Luttrell Drlg Co	—	dsl-gas	650	Unit U-15	650	8,000
King County						
W B Omohundro	10	btne	300	Brwstr N-3	—	4,500/3½"
Kleberg County						
Flournoy Drlg Co	1	gas-btne	225	Ideco HD-35	320	5,000
Stewart & Gouger Drlg Co	3	pwr	1000	Emsco GB-500	750	10,000
V & C Drlg Co	5	dsl	900	Wisn Titan	900	13,000
Knox County						
Abb Drlg Co	1	gas	185	Wisn Super	145	2,500
	2	gas	200	Wisn Mogul	165	3,500
Meredith Drlg Co	1	btne	225	Wisn Super	145	3,500
Lamb County						
Livermore Drlg Co	1	gas	870	Wisn Titan	975	12,500
	3	gas	600	Natl 75	680	10,000
Western Drlg Co Inc	6	dsl	600	—	290	6,000
	16	dsl	600	Emsco 350	290	6,000
LaSalle County						
Longhorn Drlg Corp	5	gas-btne	450	Unit U-15	675	9,000
MIM Drlg Corp	1	dsl	500	Frnks SA-4500	300	5,000
Lavaca County						
Holmes Drlg Co	2	stm	—	Emsco ECA	1000+	15,000
Symons Drlg Co	U-15	gas	500	Unit U-15	650	9,500
W P Taylor Drlg Co	2	gas	—	Natl	900	11,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Leon County						
Robert M Bass Drlg Contr	6	stm	1200	Emsco U-BLS	1000+	12,500
Travis Ward Drlg Co	1	dsl	600	Wlsn Gnt	300	6,500
Liberty County						
B B M Drlg Co	3	stm	—	Emsco UBLS-54-10	—	14,000
Big "6" Drlg Co	5	gas-btne	500	Wlsn Gnt	500	9,000
Edwards & Bissett Inc	1	gas-btne	800	Wlsn Gnt Rdair	800	8,500
Falcon Seaboard Drlg Co	18	dsl	800	Whind B-85	975	11,000
Grey Wolf Drlg Co	4	gas-btne	585	Emsco GB-500	—	9,500
Houston Oil Well Serv Co	2	dsl	—	Wlsn Titan	1000	10,000
	4	gas-btne	—	Ideco M-10,000	855	10,000
	5	stm	1000+	Natl	1000+	12,000
Meredith & Co	4	gas-gaso-btne	—	Brwstr N-75	850	11,500
Prince Marine Drlg & Expl Co	3	gas	900	"Oilwell" 66	900	10,500
Limestone County						
Halbert Drlg Co	1	gas-btne	255	Wlsn Torcair	285	5,500
Lipscomb County						
Arrow Drlg Co	22	dsl	1200	Emsco 1000	—	14,000
Baker & Taylor Drlg Co	5	gas-btne	1650	Natl 110	1650	15,000
Beckman Inc	18 (wo)	gas	150	MIW P-42	200	10,000/2⅞"
Cree Drlg Co Inc	1	gas-btne	500	Unit U-15	750	8,500
	5	gas-btne	825	Unit U-40	975	14,000
Webster Drlg Co	8	gas-btne	1050	Ideco 7-11	1050	12,000
Live Oak County						
Beard Drlg Inc	1	gas-btne	685	Wlsn Giant	250	6,000
Bilbo-Redding Drlg Co Inc	4	gas-LPG	1050	"Oilwell" 96	—	12,000
Field Drlg Co	3	dsl	1110	Emsco 500	520	10,000
Turnbull & Zoch Drlg Co	2	stm	1600	Ideco	1000+	14,000
Loving County						
Brown & Scarber Drlg Co	3	gas-btne	325	Natl T-12	280	4,500
	4	gas-btne	500	Unit U-15	500	7,500
Leatherwood Drlg Co	2	gas	440	Natl T-32	—	7,000
McDaniel & Beecherl Drlg Co	11	gas-gaso	—	Hou Prtble	—	5,000
McQueen & Stout Drlg Co	11	LPG	225	Crdwll RL	185	4,500
Madison County						
CBS Workover Co	3	gas-btne	300	Ideco H-30D	215	4,500
Meadows & Walker Drlg Co	4	gas-btne	1455	"Oilwell" 76	1005	12,000
Penrod Drlg Co	8	gas-btne	—	—	1230	10,000
Marion County						
Glenn Drlg Co	1	dsl	200	Unit U-10	300	5,000
	2	dsl	280	Unit U-15	450	8,500
Tex-Mex Drlg Co	10	gas	—	Emsco GB-500	—	9,000
Martin County						
Coroco Drlg Co	2	gas-gaso	650	"Oilwell" 96	900	15,000
Davidson Drlg Co Inc	A	gas-btne	1000	Emsco J-1250	1000	14,000
Falcon Seaboard Drlg Co	Z-10	dsl	1100	Beth 950	1350	16,000
Matagorda County						
Bilbo-Redding Drlg Co Inc	9	stm	1050	Emsco ECC	1000+	15,000
	12	stm	900	Natl 34-8-½	1000+	11,000
Henderson Drlg Corp	3	gas-btne	700	Natl 75	750	11,000
Turnbull & Zoch Drlg Co	1	stm	1600	Emsco	1000+	16,000
McMullen County						
Boyd & Durst Drlg Contr	2	gas-btne	650	Wlsn Giant	700	8,500
Buzzini Drlg Co	1	gas-btne	150	TIW	150	3,000
J E Hillier	1	dsl	400	Sullivan 300-A	200	4,000/3½"
Pegg Bros Drlg Co	2	gas-btne	110	—	110	3,000/3½"
Midland County						
B B M Drlg Co	1	gas-btne	950	Emsco GB-800	1050	14,000/4"
	8	gas-btne	450	Beth M-58	650	9,000
	9	gas-btne	1300	Unit U-30	1800	18,000
Beckman Inc	11 (wo)	gas	300	Unit U-34	300	4,500
Big West Drlg Co	17	gas-btne	600	Wlsn Titan	900	13,000
Henry Black Drlg Co Inc	2	gas	550	Natl 75	650	10,000
	4	gas	850	Natl CB-75	900	10,750
	8	gas	400	Natl 50-A	500	9,000
Delta Drlg Co	3	gas-btne	900	Natl 100	800	12,000
Exploration Drlg Co	12	dsl	1200	Natl 125	1350	16,000
Great Western Drlg Co	21	gas-gaso	840	Unit U-914A	1260	15,000
O E Hall Drlg Co	5	gas	700	Unit U-40	1210	12,000
Helmerich & Payne Inc	9	gas	1200	"Oilwell" 96	1100	14,000
Llano Drlg Co	1	dsl	1175	"Oilwell" 96	1200	15,000
	2	gas	—	Natl 100	975	14,000
Rowan Drlg Co Inc	9	gas-btne	900	Natl 75	1110	11,000
	25	gas-btne	1260	Natl 100	1680	14,000
Schoenfeld-Hunter-Kitch Drlg Co	4	LPG-gas	—	Natl 75	800	11,000
Western Drlg Co Inc	21	btne	650	Natl 100	325	10,000
Mitchell County						
Robinson Drlg Co (Colo City)	3	btne	300	Beth MC-250	300	5,000/3½"
C D Turner Drlg Co	1	dsl	—	Brwstr N-4	—	5,500
Montague County						
Alan Drlg Co	2	gas	350	Wlsn Mogul	185	4,000
Jack Grace Drlg Co	8	gas-btne	625	Wlsn Atlas	1200	10,000
Roy Guffey Drlg Co	3	gas-btne	430	Unit U-34	260	5,500
Paine Drlg Co	6	btne	500	Wlsn Giant	500	7,000
Ward Drlg Co	1	dsl	350	Wlsn Titan	750	6,500
Montgomery County						
Lubie Martin Drlg Co	1	gas	300	Brwstr N-4	400	6,000
Moore County						
Canadian River Drlg Co	1	dsl	300	Unit U-34	300	6,000
Cree Drlg Co Inc	3	gas-btne	225	Wlsn Giant	300	5,000
	8	gas-btne	185	Unit U-34	300	4,500
Urice Drlg Co	5	gas-btne	560	Wlsn Giant	560	8,000
Nacogdoches County						
Gibson Drlg Co	4	gas-btne	226	Wlsn Mogul	225	4,500
Navarro County						
M J Delaney Co	21	gas-btne	500	Wlsn Titan	650	9,500
Stroube Drlg Co	—	btne	175	Mayhew	175	1,650/2⅛"
Newton County						
Big "6" Drlg Co	4	dsl	500	Unit U-35	500	8,000
Rowan Drlg Co Inc	4	gas-btne	900	Natl 75	1149	11,000
Timberland Expl Co	3	gas-btne	800	Unit U-15	700	9,000
Nolan County						
Choya Drlg Co	1	gas	500	Emsco GB-500	550	8,500
Dixon Drlg Co	3	gas	500	Natl 50	520	7,500
Hack Drlg Co	3	btne	—	Unit U-15	412	8,500
Layton & Newell Drlg Co	1	gas-btne	500	Unit U-15	600	8,000
Lamar H Moore Drlg Co	2	btne	250	Wlsn Giant	480	7,000
	3	btne	250	Unit U-15	552	8,000
E W Moran Drlg Co	1	gas	500	Unit U-15	560	7,500
Sojourner Drlg Corp	3	dsl	550	Unit U-15	—	7,500
Wes-Tex Drlg Co	1	btne	338	Unit U-10	326	7,500
Nueces County						
Del Mar Drlg Co	6	gas-btne	—	Wlsn Gnt	750	9,500
C G Glasscock Drlg Co	1	dsl	1200	Natl 110	1200	16,000
	9	dsl	400	Natl T-20	—	6,000
	10	dsl	750	Natl 50	—	9,000
Harkins & Co	2	dsl	300	Wlsn Giant	300	6,000
Miller Bros & Bowling	1	gas-btne	495	Emsco G-300	—	5,500
Harold L Strader Drlg Co Bge 401		btne	—	Brwstr N-4	—	5,500
V & C Drlg Co	6	gas-btne	600	Natl 50	550	7,000
Ochiltree County						
Baker & Taylor Drlg Co	2	dsl	800	Unit U-15	800	8,500
	3	dsl	800	Unit U-15	800	8,500
	4	gas-btne	750	Emsco G-500	750	9,500
	6	gas-btne	750	Emsco G-450	750	9,500
	7	gas-btne	1000	Natl 55	1000	10,500
	8	gas-btne	750	Emsco G-500	750	9,000
Cree Drlg Co Inc	4	gas-btne	350	Emsco GA-500	600	9,000
	9	gas-btne	350	Unit U-15	650	8,500
Helmerich & Payne Inc	26	gas	500	Emsco GB-500	700	9,000
Midwestern Drillers Inc	8	dsl	370	Unit U-15	750	8,500
R W Rine Drlg Co	4	dsl	620	Brwstr N-75	750	9,500
Rowan Drlg Co Inc	2	gas-btne	840	Natl 75	1120	11,000
Service Drlg Co	3	LPG	650	Unit U-15	—	8,500
Rip C Underwood	1	gas-LPG	660	Unit U-15	660	9,500
Urice Drlg Co	2	gas-btne	840	Emsco GA-500	840	9,000
Wagner & Wyant Drlg Co Inc	4	gas-btne	500	Unit U-15	700	9,000
Orange County						
Howard Parker Co	3	gas-btne	500	Crdwll O	900	11,000
Southland Drlg Co	3	gas-btne	835	Crdwll O	675	10,000/5"
Timberland Expl Co	1	gas-btne	850	"Oilwell" 76	1050	10,500
Palo Pinto County						
Bolin Oil Co & D H Bolin	9	gas	185	Wlsn Super	145	4,000
Red River Drlg Co	2	gas	165	Wichtex R-4	140	3,500/3½"
Panola County						
Crow Greyhound Drlg Co Inc	2	dsl	600	Brwstr N-45M	600	7,000
Milton Crow Inc	5	gas	600	Brwstr N-7	400	7,500
Tex-Mex Drlg Co	7	gas	—	Emsco GB-350	—	7,000
Parker County						
Hunter Bros	2	gas-btne	700	Wlsn Rdair	700	8,500
	3	gas-btne	400	Wlsn Mogul	200	4,500
Pecos County						
Alan Drlg Co	3	gas	275	Wlsn Mogul	145	3,500
Blount Drlg Corp	1	gas-btne	700	Wlsn Gnt Rdair	700	8,500
	3	gas-btne	275	Unit U-34	175	5,000
Delta Drlg Co	2	gas-btne	400	Natl 50	450	7,000
Gardner Bros Drlg Co Inc	11	gas-btne	750	Natl 100	1050	12,500
Great Western Drlg	2	gas-gaso	500	Wlsn Gnt Rdmstr	840	9,000
	9	gas	1053	Unit U-20	1600	16,000
	44	dsl-elec	1400	Unit U-1220	3000	25,000
Howard C Lasiter Drlg Co	1	gas-btne	240	Brwstr N-4	340	5,000
Chas E Long Jr Inc	1	gas	200	Unit U-10	400	6,000
Norwood Drlg Co	4	gas-gaso	500	Wlsn Gnt Rdair	600	9,500
	7	gas-gaso	650	Wlsn	600	9,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Parker Drlg Co	26	gas-elec	—	Natl L-10½ FE	2000	20,000
	44	gas	—	Natl L-125	1400	15,000
Penrod Drlg Co	12	gas-btne	—	—	1425	14,000
	32	dsl	—	—	1460	15,000
Pico Drlg Co	3	gas-btne	630	Unit U-15	630	8,500
Rowan Drlg Co Inc	29	gas-btne	1200	Natl 100	1480	14,000
Reagan County						
Layton & Newell Drlg Co	2	gas-btne	450	Natl 75	780	12,000
Lomax Drlg Co	2	gas-btne	300	Unit U-15	650	8,500
Texas R F O Inc	1	gas	325	Beth S-60	360	8,000
Tri-Service Drlg Co	2	gas	675	"Oilwell" 66	675	8,500
Reeves County						
McDaniel & Beecherl Drlg Co	6	gas-gaso	—	Hou Prtble	—	5,000
Urice Drlg Co	6	gas-btne	280	Wisn Super	145	3,000
Refugio County						
Flournoy Drlg Co	4	gas-btne	175	Franks	185	3,500
Burdette Graham	1	gas-btne	738	Beth M-58	700	9,500
V & C Drlg Co	2	stm	—	Emsco 54	—	9,000
	7	gas-btne	750	Emsco 500	750	8,000
	8	gas-btne	900	Beth	900	12,000
Viking Drlg Co	1	dsl	475	Natl 50	500	8,500
	4	gas-gaso	450	Unit U-10	500	8,500
Roberts County						
Moran Bros Inc	4	gas	1100	Wisn Titan	1300	15,000
Triad Drlg Co	6	gas-btne	600	Beth M-58	600	10,000
Webster Drlg Co	9	gas-btne	—	Natl 100	1110	14,000
Runnels County						
Frank Caraway Drlg Co	1	btne-gas	225	Beth S-50	—	5,000
Cooper Drlg Co	1	gas-btne	450	Natl 50	450	6,500
Dixon Drlg Co	1	dsl-gas	260	Natl T-20	260	5,000
Johnn Drlg Co	2	gas	375	Unit U-15	400	7,500
	5	gas	375	Unit U-15	600	8,500
Moore & Moore Drlg Co	4	btne	175	Unit U-34	210	5,000
Norman Drlg Corp	2	dsl	330	Unit U-10	350	5,000
Robinson Drlg Co	4	btne-gas	155	Crdwll S	140	4,500/3½"
J B Schick Drlg Co	2	gas-btne	—	Crdwll O	450	7,000
A B See Drlg Co Inc	3	gas	700	Unit U-15	700	9,500
Rusk County						
Delta Drlg Co	22	gas-btne	530	Unit U-15	600	8,000
	40	gas-btne	325	Wisn Rdr Gnt	690	8,000
F E Hargraves & Sons Drlg Co	4	dsl	275	Brwstr N-A	300	6,000/3½"
South States Drlg Co	4	dsl	275	Emsco GA-350	480	7,000/4"
Tex-Mex Drlg Co	6	gas-btne	1200	Wisn Titan	1200	13,000
	12	gas	—	Unit U-15	—	9,000
J C Trahan Drlg Contr Inc	2	gas	600	Unit U-15	600	9,500
San Patricio County						
Appell Petroleum Corp	4	gas-gaso	315	Wisn Mogul	175	4,000
Big "6" Drlg Co	2	dsl	500	Unit U-15	550	10,000
Bilbo-Redding Drlg Co Inc	8	gas-LPG	1600	Natl 110	—	13,500
Chiles Drlg Co	2	dsl	300	Ideco H-40	300	6,000
Frio Drlg Inc	2	dsl	400	Unit U-15	400	6,500
	3	gas-btne	800	Brwstr N-55	800	10,500
Miller Bros & Bowling	3	gas-btne	850	Emsco GC-500	—	9,000
Southland Drlg Co	1	dsl	750	Emsco GA-350	500	9,000
Schleicher County						
Fortune Drlg Corp	1	gas	325	Beth S-55C	524	7,500
Great Western Drlg Co	5	gas-gaso	500	Unit U-15	770	7,500
Pico Drlg Co	2	gas-btne	600	Brwstr N-7	600	8,500
Scurry County						
Cactus Drlg Corp of Tex	8	gas-btne	675	Brwstr N-7	675	9,000
Dearing Inc	5	gas-btne	—	Wisn Giant	—	6,000
Dual Drlg Co	3	gas	600	Beth M-58	600	10,000
John Grappe Drlg Co	2	gas-btne	720	Beth	—	13,000
Chas E Long Jr Inc	3	dsl	400	Emsco GA-500	520	10,000/3½"
McCutchen & Graham	3	btne	350	Wisn Spr Gnt	650	9,000
McQueen & Stout Drlg Co	12	LPG	225	Crdwll RL	185	4,500
J E Miller Drlg Contr	1	btne	165	Natl T-8-S	145	3,400/3½"
Moore & Moore Drlg Co	6	btne	300	Unit U-15	636	9,000
Pico Drlg Co	1	dsl	427	Brwstr N-4	216	4,500/3½"
Rheay & Reynolds Drlg Co	4	gas	350	Natl 50	1200	7,000
Rhodes & Hicks Drlg Corp	3	btne	370	Crdwll S	185	4,500
Robinson Drlg Co (Colo City)	1	btne	550	Unit U-15	550	9,000/3½"
	4	btne	235	Crdwll KL-210	135	3,500/3½"
Shackelford County						
Dearing Inc	3	gas-btne	—	Wichtex	—	3,000
Gore Drlg Co	1	dsl	640	Shovel Spl	—	7,500
	2	dsl	320	Beth	—	5,000
	3	gas	254	Joy 200-A	—	2,500/2⅛"
Herb Expl Co	—	gas-gaso	—	Failing 1500	—	1,750/2¼"
Irish Drlg Co Inc	2	btne	280	Wichtex R-3	—	3,000
Lamar H Moore Drlg Co	1	btne	173	Crdwll RL	210	5,000
H F Pettigrew Drlg Co	1	—	—	Mayhew Prtble	—	—
D L Rose Drlg Contr	2	dsl	450	Beth S-55	500	7,500
Sojourner Drlg Corp	4	btne	225	Unit U-34	—	4,500
Varner-Neill Drlg Co	1	gas	500	Wisn Gnt	450	6,000
West Central Drlg Co	7	gaso-btne	225	Wisn Giant	250	5,000
Sherman County						
Cree Drlg Co Inc	6	gas-btne	255	Wisn Giant	300	5,000
	7	gas-btne	185	Emsco 250	300	4,500
Graham-Michaelis Drlg Co	5	dsl	275	Crdwll B	275	4,000
Service Drlg Co	1	dsl	320	Unit U-34	180	4,500
Smith County						
Robert M Bass Drlg Contr	1	gas-LPG	500	Wisn Rdair	800	10,000
B G Byars Power Drlg Co	1	gas-btne	1170	Beth MC-450	775	11,000
Carter-Jones Drlg Co	12	gas-btne	—	—	720	9,000
Halbert Drlg Co	2	gas-btne	285	Wisn Rdair	445	6,500
Starr County						
Appell Petroleum Corp	2	dsl	520	Frnks SG-101	400	7,000
General Well Drlg Inc	1	pwr	450	Unit U-34	200	5,500
Holmes Drlg Co	7	gas-gaso	—	Beth MC-450	1000	11,000
Turnbull & Zoch Drlg Co	3	gas-btne	1125	Wisn Titan	1125	16,000
Viking Drlg Co	3	gas-gaso	500	Unit U-15	600	9,000
John W Voss Drlg Co Inc	2	pwr	500	Brwstr N-7	750	9,000
Stephens County						
E & H Drlg Co	2	gas	275	Unit U-34	225	4,500
Ewing Drlg Co	1	btne	—	Emsco C-42	450	5,000
A F Knappenberger Drlg Co	1	gas	350	Emsco GA-500	500	7,000
Louis Pitcock Drlg Co	1	gas-btne	225	Betn S-55	600	7,500
R-G Drlg Co	2	gas-gaso	—	Wisn	650	8,000
	5	gas-gaso	—	Wilson	650	8,000
Taylor Expl Co Inc	5	gaso	—	Mayhew	75	1,000
	7	btne	—	Mayhew	—	1,200
Sterling County						
Rheay & Reynolds Drlg Co	6	gas	300	Natl 50	750	7,000
Stonewall County						
E & H Drlg Co	1	gas	550	Unit U-15	550	7,500
T F Hunter Estate	1	gas-btne	700	Wisn Rdair	700	8,500
Lauderdale & Straughan Drlg Co	1	LPG	570	Wisn Titan	—	8,000
W B Omohundro	8	btne	700	Wisn Rdair	—	8,000
St John Drlg Co	3	gas	400	Brwstr N-55	570	7,500
J B Schick Drlg Co	1	btne-gas	—	Crdwll O	500	7,500
Thomas & Billups Drlg Co	2	btne	450	Emsco 300	450	6,000
Sutton County						
Great Western Drlg Co	11	dsl	353	Wisn Gnt Rdmstr	600	9,000
Swisher County						
Norwood Drlg Co	3	gas-gaso	1050	Wisn Titan	1050	12,500
Taylor County						
Edgar Davis Drlg Co	11	gas-btne	325	Unit U-15	600	7,500
Dugger & Herring Drlg Co	1	gas-btne	500	Unit U-15	600	8,500
H O Grace Drlg Co	3	btne	—	—	—	6,000
Roy Guffey Drlg Co	6	gas-btne	560	Unit U-15	560	7,500
Hack Drlg Co	4	btne	—	—	161	2,500
Henson Drlg Co	5	btne	810	Unit U-15	810	7,500
Herb Expl Co	—	gas-gaso	—	Failing 1500	—	1,500/2⅛"
Johnson-Gadbois Drlg Co	1	gas	440	Wisn Giant	440	8,000
Low Drlg Co	3	btne	—	Wilson	165	2,500
Paine Drlg Co	5	btne	450	Wisn Giant	450	7,000
Red River Drlg Co	1	dsl	200	Wichtex R-4	165	3,000
Rhodes Drlg Co	1	gas	300	Wisn Giant	450	5,500
Robinson Drlg Co	2	btne-gas	155	Crdwll EC	155	6,000/3½"
	6	gas-btne	180	Crdwll OC	450	7,500/4"
	8	btne-gas	180	Unit U-15	450	8,500
Sojourner Drlg Corp	2	dsl	320	Unit U-15	—	5,000
West Central Drlg Co	8	gaso-btne	325	Wisn Rdair	975	10,000
	9	gaso-btne	225	Crdwll H	250	3,000
Woodson Prod Co	4	dsl	600	Mayhew 5000	270	5,500/4"
Terrell County						
Choya Drlg Co Inc	4	gas-btne	1400	Emsco J-1400	1400	15,000
Helmerich & Payne Inc	48	gas-btne	1200	Natl 110	1300	15,000
Layton & Newell Drlg Co	4	gas	600	Emsco J-1400	1800	17,000
Terry County						
Great Western Drlg Co	4	gas	307	Unit U-15	800	9,000
Hissom Drlg Co	6	gas	1000	Emsco A-800	1000	11,000
Milhoan Drlg Co	6	gas	600	Unit U-15	—	8,000
Throckmorton County						
Bolin Oil Co & D H Bolin	3	gas	350	Wisn Giant	225	5,000
Ellis & Gray	4	dsl	300	Unit U-34	300	5,000
Paine Drlg Co	7	dsl	450	Wisn Giant	450	7,000
R-G Drlg Co	1	gas-gaso	—	Wilson	650	6,500
	3	gas-gaso	—	Wilson	450	6,500
Schulz & Brannan Drlg Co	1	dsl	400	Wisn Mogul	400	5,000
A B See Drlg Co	2	gas	400	Wisn Mogul Torcair	250	5,000
Tibbits Drlg Co	2	gas	350	Wisn Giant	425	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Tom Green County						
Roy Guffey Drlg Co	4	gas-btne	560	Unit U-15	560	7,500
Tucker Drlg Co	1	gas	600	Brwstr N-55	—	9,500
	3	gas	600	Ideco TC-600	—	9,500
Tyler County						
Howard Parker Co	6	gas-btne	400	Crdwll D	500	8,000
Carnes W Weaver Drlg Co	1	gas-btne	700	"Oilwell"	—	10,500
	6	gas-btne	540	Brwstr N-7	—	8,500
Upton County						
B B M Drlg Co	4	gas-btne	400	Natl 50	600	8,500/3½"
Empire Drlg Co	3	gas	500	Brwstr N-75	975	11,000
	7	gas	600	Wisn Titan	975	13,500
Fortune Drlg Corp	2	gas	300	Unit U-15	590	7,500
Helmerich & Payne Inc	37	gas	1200	"Oilwell" 96	1450	15,000
Carl B King Drlg Co of Tex	10	gas-gaso	1000	Natl 75	1000	12,500
La Mance Drlg Co	2	btne	700	Unit U-15	—	9,500
Lomax Drlg Co	1	gas-btne	300	Unit U-15	650	8,500
B L McFarland Inc	10	gas	500	Brwstr N-55	—	8,000
Ormand Bros Drlg Co	2	gas	550	Wisn Giant	550	7,000
Penrod Drlg Co	2	gas-btne	—	—	580	7,000
St John Drlg Co	1	gas	400	Wisn Gnt Rd	700	8,500
Schoenfeld-Hunter-Kitch Drlg Co	7	LPG-gas	—	Natl 110	1200	16,000
	9	LPG-gas	—	Natl 75	900	11,000
Tri-Service Drlg Co	8	gas	900	"Oilwell" 76	900	10,000
Wilbanks & Rutter Drlg Co	1	gas	1050	Unit U-40	1050	10,000
Van Zandt County						
Big Chief Drlg Co	5	gas	1545	Emsco 1250	1545	15,000
Victoria County						
Glenn Drlg Co	3	gas	145	Crdwll S	145	4,000
Schimmel Drlg Co	1	dsl	350	Wisn Gnt Torcair	450	7,500
Southland Drlg Co	4	dsl	700	Brwstr N-7	700	9,500
Waller County						
Bilbo-Redding Drlg Co Inc	11	gas-LPG	550	Wisn Gnt	290	8,000
Ward County						
Hissom Drlg Co	2	gas	400	Unit U-34	500	6,000
McQueen & Stout Drlg Co	10	LPG	225	Crdwll RL	185	4,500
Robinson Bros Drlg Co	4	gas	300	Brwstr N-45	450	6,500
Triad Drlg Co	2	dsl	300	Beth S-45	300	6,000
Western Serv Drlg Co Inc	13	gas-btne	550	Beth S-45-E	350	5,000
Webb County						
Armstrong & Horn Drlg Co	1	dsl	450	Brwstr N-45	—	7,000
Longhorn Drlg Corp	4	gas-btne	450	Unit U-15	675	9,000
Stewart & Gouger Drlg Co	4	pwr	—	Natl 110	1100	16,000
Wharton County						
Coon-Murphy Drlg Co	2	dsl	860	Ideco 700	600	11,200
Meadows & Walker Drlg Co	3	gas-btne	900	Unit U-15	675	8,500
W P Taylor Drlg Co	3	gas	—	Natl	900	11,000
Wheeler County						
Falcon Seaboard Drlg Co	33	gas	1050	Beth 1013	1350	16,000
Wichita County						
Ayers and Burch	3	btne	185	Wichtex	—	3,000
Bolin Oil Co & D H Bolin	10	dsl	300	Wisn Giant	300	4,500
C K C Drlg Co	1	btne	110	Joy	110	1,800
T V Gorman Drlg Contr	2	dsl	300	Wisn 38 Torcair	300	4,500
Luke Grace Drlg Co	7	dsl-gas	600	Wisn Air Atlas	600	12,500
Hull Oil Co	1	btne	140	Wlkr-Nr R-2	—	2,000
Meredith Drlg Co	2	btne	500	Wisn Giant	225	7,500
E W Moran Drlg Co	6	gas	225	Wisn Mogul	160	4,500
Norwood Drlg Co	6	gas-gaso	650	Wisn Titan	900	12,000
W B Omohundro	9	btne	550	Wisn Rdair	—	6,500
Walters Drlg Co Inc	9	gaso	130	Mayhew 1000	130	800/2⅞"
Wilbarger County						
Dublin-Kiel	1	LPG	225	Wisn Mogul	190	2,500
Graytex Drlg Co	2	gas	325	Natl T-12	200	4,000
Jennings Drlg Co	4	btne-gas	450	Unit U-15	600	8,000
Lofton Oil Co	1	btne	300	Beth Breeze	—	5,500
Wilson County						
Pegg Bros Drlg Co	3	gas-btne	90	—	90	1,500/2⅞"
Winkler County						
Arrow Drlg Co	17	gas	1260	Emsco 1250	—	14,000
Robert M Bass Drlg Contr	2	gas-LPG	350	Brwstr N-45	350	7,000
Bolin Oil Co & D H Bolin	2	gas	225	Natl T-12	185	4,500
Camden Drlg Co	1	dsl	300	Natl T-20	300	5,000
Danforth Drlg Co	1	dsl	240	Ideco H-30	350	5,000
Davidson Drlg Co Inc	D	btne	315	Wisn Mogul	600	7,500
Gardner Bros Drlg Co Inc	12	gas-btne	750	Natl 100	1050	12,500
	20	gas-btne	275	Natl T-25	350	4,000
Great Western Drlg Co	16	gas-gaso	775	Unit U-914-A	1260	15,000
	18	dsl	955	Unit U-914-A	1800	15,000
Laughlin-Porter Drlg Co Inc	1	gas	800	Natl 50	—	7,000
	3	gas	416	Natl T-20	—	5,000
	6	gas	1000	Wisn Titan	—	14,000
Lowe Drlg Co	7	gas	750	Wilson	—	10,000
M & J Inc	14	gas	150	Crdwll RL	—	4,500
B L McFarland Inc	4	gas	400	Crdwll RL	—	4,500
	9	gas	400	Crdwll RL	—	4,500
Dale Mount Drlg Inc	111	gas	1200	Emsco	1200	14,000
Parker Drlg Co	33	gas	—	Natl 75	1000	11,000
Pico Drlg Co	4	gas-btne	150	Wisn Mogul	325	4,000
Pool & Gerlich Drlg	D-2	gas	260	Unit U-34	300	5,000
Texas Drlg Co	1	gas	300	Natl T-20	300	5,000/3½"
A W Thompson Inc	5	gas	650	Beth 810	1050	13,500
	10	gas	600	Clark Pr-1000	1050	13,500
Western Serv Drlg Co Inc	12	dsl	250	Natl T-20	520	4,000
Akin & Dimock	2	dsl	300	Beth S-55	420	7,000
Bolin Oil Co & D H Bolin	6	gas	350	Wisn Gnt Rdair	250	6,500
Carter-Jones Drlg Co	6	gas-btne	—	—	350	6,800
	7	gas-btne	—	—	300	6,500
	11	gas-btne	—	—	280	6,500
Frank Frawley Drlg Co	5	gas	—	Unit U-15	675	8,500
Jack Grace Drlg Co	5	gas-btne	500	Wisn Atlas	700	10,000
	17	gas-btne	370	Wisn Giant	700	8,000
Luke Grace Drlg Co	6	dsl-gas	300	Wisn S E Gnt	300	6,500
Hamman Oil & Ref Co	7	dsl	340	Brwstr N-75	600	11,000
John W Harris Drlg Co	1	gas	500	Hou Prtble	450	6,500
	2	gas	500	Emsco GC-500	500	8,000
John Haseman Inc	1	gas-btne	350	Ideco H-35D	300	6,000
	2	gas-btne	150	Wisn Super	150	3,500
	4	gas-btne	150	Crdwll K-200	150	3,500
Karper & Glass	2	gas	425	Beth C-50	425	6,000
	3	dsl	450	Beth S-55	450	7,000
E W Moran Drlg Co	4	gas	300	Unit U-15	650	7,500
Pan-Tex Drlg Co	1	gas	350	Brwstr N-45	400	6,500
Revier Drlg Co	1	gas-btne	700	Unit U-15	700	8,500
	2	gas-btne	600	Wisn Giant	600	7,000
	3	gas-btne	350	Brwstr CRB	290	4,500
Tibbits Drlg Co	3	gas	350	Wisn Giant	560	7,500
Trio Drlg Co	1	gas	520	Wisn Giant	—	8,000
	2	dsl-gas	520	Crdwll O	—	8,500
	3	gas	450	Wisn Giant	—	6,500
	4	gas	450	Natl 50	—	6,500
Walters Drlg Co Inc	12	dsl	—	Mayhew 1000	300	400/2⅛"
Wood County						
Robert M Bass Drlg Contr	4	gas-LPG	300	Wisn Giant	300	5,500
M J Delaney Co	25	stm	—	Emsco UBLS 54	—	15,000
	28	gas-btne	500	"Oilwell" 96	1000	14,000
Delta Drlg Co	15	gas-btne	530	Unit U-15	600	8,000
Gibson Drlg Co	1	gas-btne	275	Wisn Mogul 42	265	5,000
Yoakum County						
Brantly Drlg Co Inc	6	gas	400	Natl 50	750	9,000
Dual Drlg Co	1	gas	600	Wisn Giant	600	9,000
Empire Drlg Co	10	gas	325	Brwstr N-4	275	5,500
Gardner Bros Drlg Co Inc	14	gas-btne	750	Natl 100	1050	12,500
B L McFarland Inc	6	gas	1000	Brwstr N-95	—	14,000
Ormand Drlg Co Inc	1	gas	550	Wisn Giant	550	7,000
Fred Pool Drlg Co	3	gas	225	Wisn Giant	250	5,500
Tibbits Drlg Co	5	gas	350	Wisn Gnt	560	7,500
Young County						
American Drlg Corp	2	gas-btne	450	Emsco 750	450	7,500
D-D Drlg Co	1	btne	145	Wisn Sr	135	2,500
Hamilton Investment Co	1	btne	350	Wisn Giant	225	6,500
Hamilton-Powell Drlg Co Inc	1	gas	225	Wisn Mogul	—	4,500
J W Hastings Drlg Co	4	gas-btne	330	Wisn Torcair	220	5,000
	5	gas-btne	864	Wisn Gnt Rdair	864	8,200
Karper & Glass	6	gas	276	Wilson	212	3,500
A F Knappenberger & A B Henley	2	gas	200	Wisn Mogul	400	5,000
Norwood Drlg Co	8	gas-gaso	300	Wisn	175	4,000
Oney Drlg Co	5	gas	250	Crdwll S	200	4,000
Sheets & Walton Drlg Co	3	pwr	365	Brwstr N-4	285	5,000
Turner & West	1	gas	300	Natl T-32	300	5,500
Zapata County						
Del Mar Drlg Co	3	gas	690	Natl 75	750	10,500
Zavala County						
Bay City Drlg Co Inc	2	gas-btne	300	Unit U-34	300	5,000
Sutton Drlg Co	4	dsl	350	Brwstr N-4	875	6,500
UTAH						
Carbon County						
Mountain States Drlg Co Inc	11	gas-dsl	1000	Natl 80-B	—	12,500
	15	gas-dsl	1400	Natl 125	—	15,000
Grand County						
Exploration Drlg Co	11	gas	800	Beth S-60	480	8,000
	15	gas	800	Natl 75-CA	900	11,000
Hewit-Gulick Drlg Co	3	gas-btne	600	Natl 50-CA	900	8,000
Willard Pease Drlg Co	1	dsl	340	Stratmaster 90	320	5,500/3½"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
San Juan County						
Arapahoe Drlg Co	2	gas-btne	300	Natl T-32	320	6,000
	4	gas-btne	375	Natl 50-A	680	8,000
Basin Drlg Corp	1	gas	600	Unit U-15	600	8,000
	2	gas	600	Unit U-15	600	8,000
Calvert Drlg Inc	20	dsl	350	Ideco H-525	600	8,500
Camay Drlg Co Rocky Mt Div	3	dsl	560	Natl 50-A	450	8,500
	5	gas	680	Natl 50-A	450	7,500
	6	dsl	260	Johnson	450	5,000
D-K Drlg Co	3	gas	500	Natl 50	500	6,500
Exeter Drlg Co	3	btne	630	Natl 50-A	630	8,500
Exploration Drlg Co	1	gas	470	Beth S-60	500	8,000
	8	gas	670	Unit U-15	600	8,000
	16	gas	625	Natl 75	600	9,000
Gardner Bros Drlg Co Inc	17	gas-btne	550	Natl 50-A	700	8,500
Great Western Drlg Co	14	dsl	320	Unit U-15	800	9,000
	30	dsl	500	Unit U-15	750	7,500
	42	dsl	500	Emsco G-500	800	9,000
Kerr-McGee Oil Ind Inc	1	gas	825	Unit U-15	832	10,000
R L Manning Co	4	gas-btne	600	Emsco 450	450	7,000
	12	gas-btne	550	Emsco GA-350	450	7,000
	16	gas-btne	475	Natl T-32	450	6,000
Miracle-Fifer Drlg Co	2	btne	300	Unit U-15	760	8,500
	3	btne	300	Unit U-34	420	6,000
Moran Bros Inc	7	gas	700	Wisn Giant	750	10,000
	9	gas	800	"Oilwell" 66	750	10,000
	16	gas	650	Unit U-15	700	7,500
Mountain States Drlg Co Inc	6	dsl	600	Natl 50	—	7,500
George Noland Drlg Co Inc	9	gas-btne	—	Emsco G-500	730	8,500
Rhodes Drlg Co	5	gas	450	Unit U-15	675	9,000
	11	gas	240	Emsco 350	360	5,000
R W Rine Drlg Co	2	dsl	520	Brwstr N-7	600	8,500
	6	dsl	520	Brwstr N-75	750	12,000
Paul F Rutledge	4	gas	525	Beth C-50	525	7,000
Uintah County						
Falcon Seaboard Drlg Co	MA-1	gas-btne	300	Unit U-35	210	6,500
Kerr-McGee Oil Ind Inc	4	gas	900	Natl 75	832	11,500
	23	gas	650	Natl 50	556	9,000
Mountain States Drlg Co Inc	3	gas-dsl	600	Natl 50-A	—	7,500
	4	gas-dsl	600	Emsco GB-500	—	9,000
WASHINGTON						
Grays Harbor County						
Colorado Wyoming Drlg Co	2	dsl	668	Natl 55	668	12,000
Pend Oreille County						
Terminal Drlg & Prod	7	dsl	320	Howard-Turner	120	2,500/3½"
WEST VIRGINIA						
Greenbrier County						
Gordon Drlg Co	10	gas-LPG	600	"Oilwell" 66	500	9,500
Jackson County						
Delta Drlg Co	27	dsl	380	Emsco GA-350	350	6,00
Tyler County						
Delta Drlg Co	29	dsl	750	Emsco J-750	750	12,000
WYOMING						
Big Horn County						
A O Bullock Drlg Co	1	gas	225	Wichtex R 5	—	3,500
Campbell County						
Falcon Seaboard Drlg Co	9	gas-btne	325	Unit U-15	450	8,500
Hewit-Gulick Drlg Co	1	dsl	970	Natl 50-A	600	8,000
A L Schlaikjer	1	gas	700	Wisn Gnt Rdair	—	8,000
Carbon County						
Carpenter-Trant Drlg Co	9	dsl	250	Franks	300	5,000
Delta Drlg Co	23	dsl	520	Emsco GA-500	500	8,000
Converse County						
A O Bullock Drlg Co	2	gas	225	Crdwll S	—	4,000
Dyer Drlg Co	2	gas-gaso	325	"Oilwell" 64-B	480	7,000
	4	dsl	185	Failing 66	300	3,500
R L Manning Co	7	gas-btne	750	Emsco G-500	750	8,000
Crook County						
Olds & Wrather Oil Co	2	gas	675	Emsco GB-350	675	7,000
True Drlg Co	4	gas-gaso	400	Emsco GA-250	250	6,000
	5	elec	400	Emsco H-46	400	9,000
	8	gas-gaso	500	Natl 50	500	7,500
	10	gas-LPG	675	Unit U-15	675	8,500
Anschutz Oil Co Inc	8	gas	900	Unit U-15	650	8,500
Kerr-McGee Oil Ind Inc	28	gas	770	Natl 75	832	11,500
R L Manning Co	2	gas-btne	600	Emsco 300	300	5,500
	11	gas-btne	1000	Emsco J-1000	1305	13,000
	17	gas-btne	1045	Emsco GC-500	770	10,000
George Noland Drlg Co Inc	10	gas-btne	—	Emsco PDM-36	440	5,500
Taylor Expl Co Inc	2	gaso	—	Failing	—	1,500
	4	gaso	—	Mayhew	75	1,000
Hot Springs County						
Arrow Drlg Co	14	gas	600	Wisn	—	8,000
R L Manning Co	15	dsl	540	Emsco GB-250	340	6,000
George Noland Drlg Co Inc	6	gas-btne	—	Wisn Mogul	440	4,000
Johnson County						
Anschutz Oil Co Inc	10	dsl	800	Brwstr N-55	600	8,000
Carpenter-Trant Drlg Co	5	dsl	900	Brwstr	900	12,000
Roden & McRae Drlg Corp	1	dsl	255	Emsco GA-350	570	5,000
True Drlg Co	7	dsl	185	Failing	165	3,500
Lincoln County						
Kerr-McGee Oil Ind Inc	31	gas	1000	Natl 100	1680	15,000
Natrona County						
Big Horn Drlg Co Inc	3	dsl	600	Emsco GB-250	360	6,500
Black Hills Drlg Co Inc	2	dsl	1000	Emsco GA-500	—	12,000
Bueno Drlg Co	1	dsl	700	Natl T-20	270	5,000
Hose-Austin Drlg Corp	4	gas	500	Emsco GB-350	588	7,500
Morrison Drlg Co Inc (Wyo)	8	dsl	210	Franks Comet	225	5,000
Reserve Drlg Co Inc (Casper)	3	gas-LPG	500	Natl 50	500	7,500
Roden & McRae Drlg Corp	6	dsl	122	Franks Rocket TD44	180	2,000
J D Sprecher	5	dsl	350	Brwstr N-45	350	6,500
Niobrara County						
Don M Rounds Drlg Co Inc	1	dsl	500	Natl 50	500	6,000
Park County						
Carpenter-Trant Drlg Co	6	dsl	450	Wisn Giant	640	7,500
Hose-Austin Drlg Corp	1	dsl	350	Emsco GB-250T	450	6,000
Mountain States Drlg Co Inc	9	gas-dsl	1400	Natl 125	—	15,000
	17	dsl	540	Natl T-32	—	6,000
George Noland Drlg Co Inc	11	gas-btne	—	Unit U-15	730	8,500
Roden & McRae Drlg Corp	2	dsl	185	Emsco GA-300	270	4,500
	5	gas	255	Emsco GA-250T	270	4,500
Sheridan County						
Anschutz Oil Co Inc	9	gas	800	Natl 50-A	600	8,500
Sublette County						
Big Horn Drlg Co Inc	1	dsl	220	Brwstr N-4	375	4,500
Kent Drlg Co	1	gas	—	Natl 75 CE	1050	10,500
	2	gas	—	Natl 50	1200	7,500
R L Manning Co	5	gas-btne	750	Emsco G-500	750	8,000
Mountain States Drlg Co Inc	2	gas-dsl	1000	Emsco J-750	—	10,000
Sweetwater County						
Carpenter-Trant Drlg Co	8	btne	800	Wisn Spr Gnt	1320	12,000
Falcon Seaboard Drlg Co	25	dsl	212	Beth S-55	212	6,500
Will I Lewis Drlg Co	5	dsl	1000	"Oilwell" 76	1000	12,000
Nye & Snell Drlg Co	3	gas	600	Wisn Atlas	800	11,000
Washakie County						
Clark Drlg Co	—	dsl	—	Natl 50	525	6,500
Delta Drlg Co	18	dsl	600	Natl 75	650	9,500
	28	dsl	350	Franks SAL-6000	600	5,000
Don Johnston Drlg Co	5	gas-btne	775	Natl 75	775	10,000
R L Manning Co	6	gas-btne	900	Emsco GB-800	1125	11,000
	10	gas-btne	1275	Emsco J-750	1125	11,000
Mountain States Drlg Co Inc	14	dsl	800	Ideco M-1000	—	10,000
George Noland Drlg Co Inc	7	gas-btne	—	Emsco PDM-36	440	5,000
Rowan Drlg Co Inc	31	gsa-btne	900	Natl 75	1149	11,000
Weston County						
Olds & Wrather Drlg Co	1	dsl	300	Wisn Rdair Mogul	300	5,000
	3	gas	1200	Beth 450	1200	11,000
	4	dsl	300	Wisn Gnt	300	4,000
True Drlg Co	6	gas-gaso	500	Beth Twister	600	8,500
Dyer Drlg Co	1	gas-gaso	325	Natl T-32	365	6,000

IF YOU NEED A WELL SERVICING UNIT . . . for jobs all the way from pulling tubing to well workovers . . . check the NEW feature added to this edition of your RIG LOCATOR. Starting on page R-42 is a list of well servicing contractors, followed by a detailed breakdown of well servicing or pulling units as to type, capacities, and where these units are working. This NEW SECTION includes all principal types of well servicing units in the U. S. and Canada.

U. S. Contract CABLE TOOL Drilling Rigs

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
ALABAMA						
Chas E Hipp Co	14	btne	145	4000	5000	B Erie 36-L
Talladega County						
Harry L Cullet	1	gas-gaso-btne	125	3000	3500	Crdwll H
	2	gas-gaso-btne	150	5000	5500	Star Spdr
	3	gas-gaso-btne	250	7000	7500	Special
ARIZONA						
Mohave County						
Aldridge & Stroud Inc	6	LPG	145	4500	4500	Wichita 61
ARKANSAS						
Union County						
H F Hatcher & Son	1	gas-gaso-btne	140	4000	5500	Crdwll KL-225
CALIFORNIA						
Ventura County						
United Drlg Co	2	gas	75	2000	—	Keystone A-50
COLORADO						
Routt County						
Western Drlg Co Inc	5	btne	185	—	—	B Erie 48-L
	7	dsl	185	—	—	B Erie 48-L
ILLINOIS						
Christian County						
LaMac Oil Co	2	gas	75	4000	4500	B Erie 24-L
C W Strotman Drlg Co	1	gas	145	3600	4500	Crdwll H
V S & S Drlg Co	1	gas	—	—	2000	Wichtex
Clinton County						
Graham Powell	1	btne	500	4200	4200	B Erie 36-L
Coles County						
C W Strotman Drlg Co	3	gas	130	3000	3500	Crdwll K
Fayette County						
Cummins Drlg Co	C-1	gas-gaso	65	1500	2000	B Erie 24-L
	C-2	gas-gaso	65	1500	2000	B Erie 24-L
	C-3	gas-gaso	65	1500	2000	B Erie 60-L
	C-4	gas-gaso	65	1500	2000	B Erie 60-L
	C-5	gas-gaso	78	2500	3500	B Erie 28-L
Franklin County						
C E Brehn	4	btne	184	—	5000	Crdwll K
Gallatin County						
V S & S Drlg Co	3	gas	—	3500	3500	Cooper
Hamilton County						
C E Brehn	8	btne	184	—	5000	Crdwll K
Jasper County						
J W Rudy	3	btne	130	—	4000	Crdwll K
Lawrence County						
Houchins Drlg Co	2	gaso	150	5000	—	Franks Spddr
Payne Bros Drlg Co	1	dsl	150	3000	4000	B Erie 36-L
	2	dsl	150	3000	4000	B Erie 36-L
Marion County						
E H Adams Drlg Co	2	gas-btne	125	2000	3000	Franks
Perrine & Perrine Drlg Contr	2	btne	145	—	6000	B Erie 36-L
Wabash County						
Payne Bros Drlg Co	3	dsl	150	3000	4000	B Erie 36-L
White County						
Don Slape Drlg Co	1	btne	—	—	—	Crdwll K
C W Strotman Drlg Co	4	gas	175	3500	4000	B Erie 36-L
INDIANA						
Gibson County						
Princeton Mining Co	1	gas	175	—	3500	Crdwll Mobil
C W Strotman Drlg Co	2	gas	145	3600	4500	Crdwll H
Vigo County						
Cummins Drlg Co	C-6	gas-gaso	78	2500	3500	B Erie 28-L
IOWA						
Dallas County						
Kirby Oil Ind	—	gas-gaso	145	—	—	B Erie 28-L
KANSAS						
Barber County						
Patton Drlg Co Inc	3	gas	—	—	—	Crdwll
Barton County						
Sage Drlg Co Inc	1	LPG	150	5000	5000	B Erie
Butler County						
Carter Drlg Co	1	LPG	145	3500	6500	Wlkr-Nr S-43
Strait Drlg Inc	1	gas	175	3500	4000	B Erie 36-L
J H Wagner Drlg Co	3	gas-LPG	145	3500	4500	B Erie 36-L
Chautauqua County						
K & S Drlg Co	1	LPG	—	2500	—	B Erie 28-L
Cowley County						
Butler County Drlg Co	1	dsl	130	3500	5000	Natl 3A-6
SeRoBee Drlg Co Inc	2	btne	—	4000	—	Crdwll RL
Earl F Wakefield	2	gas-btne	220	5500	9500	B Erie 48-L
Elk County						
R L Horn & Sons Drlg Co	1	dsl	60	1600	2000	Star 72
Ellis County						
K Smith Cable Tools	1	gas-prop	145	3000	5000	Wlkr-Nr
Graham County						
Heathman Oil	1	dsl	—	4500	4500	Crdwll Spdr Rl
Greenwood County						
J H Wagner Drlg Co	2	gas-LPG	145	3500	4500	B Erie 36-L
Hamilton County						
Graham-Michaelis Drlg Co	4	dsl	175	—	8000	Crdwll RL
Labette County						
Veeder Supply & Dev Co	BE 2	dsl	120	3500	4500	B Erie
Russell County						
Shields Oil Producers	2	dsl	160	3500	7000	B Erie 48-L
	3	dsl	160	3500	7000	Crdwll RL
Earl F Wakefield	1	gas-btne	220	5500	9500	B Erie 48-L
Sedgwick County						
Carter Drlg Co	3	LPG	160	2000	4500	Wisn Mogul
SeRoBee Drlg Co Inc	1	btne	—	4000	—	Crdwll RL
Stevens County						
Graham-Michaelis Drlg Co	2	dsl	175	3000	8000	Crdwll
Sumner County						
Carter Drlg Co	2	LPG	145	2000	4500	Wlkr-Nr C-33
KENTUCKY						
Daviess County						
Marhill Oil & Gas Co Inc	1	gas-btne	145	6000	6000	B Erie 36
Hopkins County						
W L Dillier	1	gas	65	1500	2000	B Erie 60-L
Riley & Gammon	1	dsl	50	1200	1800	B Erie 22
Webster County						
Riley & Gammon	2	gaso	30	600	1000	B Erie 20
MICHIGAN						
Gladwin County						
Goll Graves & Mechling Inc	1	LPG	—	5000	6000	B Erie 36-L
Hillsdale County						
Gordon Drlg Co	5	gas-LPG	150	4000	5000	Crdwll H
McClure Oil Co	1	gas	145	5000	5000	B Erie 36-L
Union Rotary Corp	1	gas-gaso-LPG	120	5000	7000	Crdwll KL
	2	gas-gaso-LPG	120	5000	7000	Crdwll KL
	6	gas-gaso-LPG	180	7500	10,000	Crdwll RL
Jackson County						
Union Rotary Corp	5	gas-gaso-LPG	150	7500	10,000	Crdwll RL
Lake County						
Union Rotary Corp	3	gas-gaso-LPG	150	7500	10,000	Crdwll RL
Macomb County						
Goll Graves & Mechling Inc	2	LPG	—	5000	6000	B Erie 36-L
Mecosta County						
Union Rotary Corp	4	gas-gaso-LPG	150	7500	10,000	Crdwll RL
Monroe County						
Bernhardt Drlg Co	1	btne	175	4000	—	B Erie 36
Montcalm County						
McClure Oil Co	2	gas	145	5000	5000	B Erie 36-L
	3	gas	145	5000	5000	B Erie 36-L
Ottawa County						
McClure Oil Co	1	gas	145	4500	4500	B Erie 36-L
MONTANA						
Glacier County						
Oien Oil Corp	1	dsl	150	3000	5000	B Erie 36-L
	2	gas-LPG	150	3000	5000	B Erie 36-L
Liberty County						
B & B Drlg Co (Montana)	1	gas	145	3500	—	B Erie 36-L
Teton County						
J W Lawrence	1	gas-gaso	125	3500	—	Natl
Treasure State Drlg Co	1	gas	140	3500	4500	B Erie 36-L
NEBRASKA						
Banner County						
Eatmon Drlg Co	1	prop	—	—	8000	Crdwll RL
Kimball County						
Eatmon Drlg Co	2	prop	—	—	8000	Crdwll RL
	3	prop	—	—	6000	Wlkr-Nr
Richardson County						
Nemaha Oil Co	1 (wo)	gas	150	—	4500	Wichtex C-60
NEVADA						
Churchill County						
Barry Well Drlg	3	gaso	85	—	500	Custom

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
NEW MEXICO						
Chaves County						
Keyes Drlg Co	4	LPG	53	1500	2500	B Erie 24-L
Eddy County						
Aldridge & Stroud Inc	2	LPG	525	2500	5000	B Erie 36-L
Collier Drlg Co	1	gas-gaso	145	5000	—	B Erie 36-L
	2	dsl	—	5000	—	Wich 66
	3	gas	175	5000	5000	B Erie 36-L
Kersey & Company	1	gas-gaso	185	5000	5000	Natl 3
	2	gas-gaso	120	3000	3500	Wich Spddr 55
	3	gas-gaso	120	4000	4500	Wich Spddr 61
	4	gas-gaso	120	4000	4500	Natl 3
Needham Drlg Co	1	LPG	180	5000	—	Wich Spddr 66
	2	LPG	180	5000	—	Wich Spdr 66
S P Yates Drlg Co	3	LPG	150	3500	—	Wichita 55
	4	LPG	130	3000	—	Ft Wrth Spr J
	5	LPG	180	6000	—	Ft Wrth Jumbo J
	6	LPG	180	6000	—	Ft Wrth Jumbo J
Lea County						
Art West Drlg Co	3	gas	145	—	6000	Crdwll KL
	7	gas	145	—	8000	Crdwll RL
OHIO						
Hocking County						
R A Cooper Drlg Co	1	gas	—	4000	4000	Natl 12
OKLAHOMA						
Beaver County						
Chambless-Rosen Drlg Co	4	gas-btne	145	—	10,000	Crdwll RL
Dunnam & Wyant Drlg Co	1	LPG	145	—	8000	Crdwll RL
Graham-Michaelis Drlg Co	1	dsl	175	3000	8000	Crdwll
Caddo County						
G H Ray Well Service Co	1	gaso-gas	—	12,000	—	Wisn Master
	5	gaso-gas	—	12,000	—	Crdwll RL
	6	gaso-gas	—	12,000	—	Crdwll S-60
	8	gaso-gas	—	12,000	—	Crdwll
Creek County						
Acacia Drlg Co	1	btne	175	4500	4500	B Erie 36-L
	3	btne	175	4500	4500	B Erie 36-L
Duke Anderson Drlg Co	3	btne-gas	145	—	9000	Crdwll R
Bennett Drlg Co	2	LPG	—	3500	4000	Star 45
	9	LPG	—	3500	4500	Wlkr Nr 34
4-J Drlg and Well Serv Co	1	gaso	—	—	4500	B Erie 36-L
	2	gaso	—	—	3500	Wlkr-Neer
Garfield County						
Hayward Drlg Co	2	gas	145	4000	—	Brwstr
Grant County						
Sooner Drlg Co	2	LPG	145	5000	7500	Wlkr-Nr
	4	LPG	145	5000	7500	Wlkr-Nr
Kay County						
Mora Drlg Co	4	gas	300	7000	—	Wisn Giant
Dave Morgan Drlg Co	—	LPG-gas	145	—	6500	Crdwll RL
Kiowa County						
Dublin-Kiel	2	LPG	140	2000	3000	Wlkr-Nr S-32
Ellis Drlg Corp	1	btne	45	2400	3000	B Erie 28-L
Lincoln County						
Foster Drlg Co Inc	1	prop	135	—	3500	Cooper
	3	prop	135	—	4000	Wlkr-Nr
Logan County						
Duke Anderson Drlg Co	1	btne-gas	145	—	9000	Crdwll R
	—	gas-btne	145	—	6000	Wlkr-Nr C-34
Chambless-Rosen Drlg Co	3	gas-btne	145	—	10,000	Crdwll RL
Muskogee County						
Ralph G Ladd	1	gas-gaso	65	1750	2500	Star Spddr K
Noble County						
Chambless-Rosen Drlg Co	2	gas-btne	145	—	10,000	Crdwll RL
Seiboldt Drlg Co	1	gas-btne	165	7000	9000	Wlkr-Nr
Nowata County						
Bennett Drlg Co	6	LPG	—	1750	2250	B Erie 24-L
	10	LPG	—	2000	2500	B Erie 60-L
Okfuskee County						
Skinner & McDougal Drlg Co	1	gaso-btne	145	4000	6500	Cardwell
	2	gaso-btne	145	4000	5500	Wlk-Neer
Okmulgee County						
Acacia Drlg Co	2	btne	175	4500	4500	B Erie 36-L
Bennett Drlg Co	8	LPG	—	2750	3250	B Erie 28-L
D & J Drlg Co	—	btne	140	5000	5000	Star Spddr 45
Gold-Mar Drlg Co	1	LPG	125	2500	3500	Wich Spddr 25
Smallwood & Son	2	btne	—	3500	5600	B Erie 36-
Osage County						
Mora Drlg Co	7	gas	200	3500	—	Natl T-12
Tolson Drlg Co	1	LPG	145	4000	5000	Wlkr-Nr S-33

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
Payne County						
Duke Anderson Drlg Co	A	btne-gas	140	—	4500	B Erie 36-L
	2	btne-gas	145	—	9000	Crdwll R
Mora Drlg Co	1	dsl	250	5000	—	Wisn Mogul
Skinner & McDougal Drlg Co	3	gaso-btne	145	4000	5500	Cardwell
Seminole, County						
Mora Drlg Co	6	dsl	250	5000	—	Wisn Mogul
G H Ray Well Serv Co	7	gaso-gas	—	4500	—	Wilson
Tulsa County						
Bar-Lee Drlg Co	1	LPG	120	3000	3500	Wlkr-Nr 32
Triple S Drlg Co	—	btne	120	2500	3500	B Erie 60-L
Wagoner County						
W C Baily	—	btne	90	1500	2000	B Erie 60-L
W C Cottris	—	btne	90	1500	2000	B Erie 28-L
Carl Knox Drlg Co	—	btne	120	2500	3500	B Erie 28-L
Alfred Mir Drlg Co	—	btne	130	2500	3500	B Erie
Washington County						
Bennett Drlg Co	3	LPG	—	2750	3250	B Erie 28-L
	5	LPG	—	2750	3250	B Erie 28 L
K & S Drlg Co	2	LPG	—	2500	—	B Erie
PENNSYLVANIA						
Bucks County						
C S Garber & Sons Inc	29	gas-gaso	32	1500	—	—
	30	gas-gaso	32	1500	—	—
	31	gas-gaso	32	1500	—	—
	32	gas-gaso	32	1500	—	—
	33	gas-gaso	32	1500	—	—
	34	gas-gaso	32	1500	—	—
Clearfield County						
Fairman Drlg Co	2	dsl	225	7500	8000	B Erie Spddr 48-L
	3	gas	225	7500	8000	B Erie Spddr 48-L
Fayette County						
Cecil Chisler & Son	2	gas-gaso	145	5000	5000	B Erie Spddr 36-L
Indiana County						
Fariman Drlg Co	4	gas	225	7500	8000	B Erie Spddr 48-L
	5	dsl	170	5000	6000	B Erie Spddr 36-L
Potter County						
Fairman Drlg Co	1	dsl	225	7500	8000	B Erie Spddr 48-L
TEXAS						
Archer County						
Ramey Well Service	1	LPG	140	—	8000	Wichtex E 75
Caldwell County						
C & S Drlg Co	2	gaso	110	1600	1600	Axtel 10
Clay County						
Lin-Mour Drlg Co	2	gas	125	—	6500	Wlkr-Nr C-34
	3	btne	100	5000	—	Wlkr-Nr C-33
Cochran County						
Western Drlg Co Inc	2	btne	145	—	—	B Erie 36-L
	4	btne	185	—	—	B Erie 48-L
	8	btne	185	—	—	B Erie 48-L
Coleman County						
W H McGarr Ind	2	gas-LPG	100	2500	2500	Ft Wrth Spr D
Cooke County						
Chas E Hipp Co	16	btne	145	4000	5000	B Erie 36-L
	19	btne	225	6000	9000	B Erie 48-L
Russell & Russell Drlg & Prod Co	1	gaso	80	2500	2500	Ft Wrth Spr H
Crockett County						
Aldridge & Stroud Inc	9	LPG	—	6000	6000	Ft Wrth J
	11	—	145	4000	4000	Wichita 55
James Smith Drlg Contr	1	gaso-LPG	145	3500	4500	B Erie 36-L Spdr
Culberson County						
Aldridge & Stroud Inc	10	—	145	4000	4000	B Erie 60-L
The Theiss Drlg Co	3	gaso	100	3000	4000	Wlkr-Nr S-32
Eastland County						
Kent & Preston	2	btne	120	4000	4000	Ft Wrth Jumbo
Ector County						
Eastland Drlg Co	6	gas	125	4500	6000	B Erie
McQueen & Stout Drlg Co	16	LPG	185	5000	5000	Crdwll RL
	18	LPG	145	5000	—	Natl 3
Art West Drlg Co	5	gas	185	—	8000	Crdwll RL
	9	gas	185	—	9000	Wisn Giant
Gray County						
C P Drlg Co	3	gas-btne	125	3500	4000	B Erie 36-L
	6	gas-btne	125	3500	4000	Wisn Mogul
C F Hills Drlg Co	2	gas-btne	145	5000	9000	Wlkr-Nr S-33
	3	gas-btne	145	6000	7800	Wlkr-Nr C-34
I J Huval Well Serv Co	1	gas-gaso-LPG	145	4000	10,000	Wisn Mogul Spdr
	2	gas-gaso-LPG	145	4000	10,000	Wisn Mogul Spdr
	—	gas-gaso-LPG	145	5000	10,000	Wisn Mogul Spdr
Murphy & McKernan	1	gas-gaso	145	4500	5500	B Erie 36-L
	2	gas-gaso	145	4500	5500	B Erie 36-L

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
Howard County						
C D Turner Drlg Co	1	btne	145	3500	8000	Wikr-Nr C-37
Hutchinson County						
Graham-Michaelis Drlg Co	3	dsl	150	3500	6000	B Erie 36
Robinson Brothers Drlg Co	1	gas	200	4500	5000	B Erie 48-L
Lamb County						
Western Drlg Co Inc	10	btne	185	—	—	B Erie 48-L
Lubbock County						
Western Drlg Co Inc	3	btne	145	—	—	B Erie 36-L
Maverick County						
Errol Elkins Drlg Co	2	LPG	150	5000	6500	B Erie 36-L
	2	LPG	150	5000	6500	B Erie 36
W H McGarr Ind	1	gas-LPG	120	4500	4500	Wich 61
Louis Pitcock Drlg Co	3	dsl	225	6000	7000	Wich 66
McCulloch County						
Kent & Preston	1	dsl	160	6000	—	Ft Wrth J-37
Midland County						
E H Adams Drlg Co	1	gas-btne	150	4000	8000	Crdwll
Chas E Hipp Co	11	btne	225	6000	9000	B Erie 48-L
Mitchell County						
Ellis Drlg Corp	3	btne	60	4000	5000	B Erie 36-L
The Theiss Drlg Co	4	gaso	100	3500	4500	Wikr-Nr S-43
Montague County						
Chas E Hipp Co	17	btne	225	6000	9000	B Erie 48-L
Pecos County						
R L Bob Clark Drlg Contr	2	LPG	90	3500	4500	B Erie
Reagan County						
Wilbanks & Rutter Drlg Co	2	gas	—	—	—	—
Reeves County						
Aldridge & Stroud Inc	1	LPG	140	4000	5000	B Erie 36-L
	8	LPG	145	4500	4500	Wichita 61
Scurry County						
Ellis Drlg Corp	2	btne	45	2400	3000	B Erie 28-L
Shackelford County						
J Conley Miles Drlg Co	1	btne	114	2500	3500	Ft Wrth D
W H Varner Drlg Co	1	gaso	75	1500	—	B Erie 22-W
	1	btne	150	—	—	Wisn Spr
Sherman County						
C P Drlg Co	8	gas-btne	125	3500	4000	B Erie 36-L
Taylor County						
Jones Well Serv Co	1	gas-gaso	175	3500	6000	B Erie 36-L
	2	gas-gaso	175	3500	6000	B Erie 36-L
	3	gas-gaso	175	3500	6000	B Erie 36-L
West Central Drlg Co	2	gas-gaso	—	—	—	Ft Wrth J
Travis County						
C & S Drlg Co	1	gaso	120	1800	1800	Ft Wrth Spr D
W Hugh Glass Drlg Co	—	gaso	40	1250	1500	Ft Wrth Spddr Jumbo N
Upton County						
Buck Jones Drlg Co	1	btne	140	4000	4000	Wikr Nr 33
	2	btne	100	2500	2500	Wikr-Nr 32
	3	btne	150	5000	5000	Natl 3
McQueen & Stout Drlg Co	20	LPG	185	5000	5000	Crdwll RL
Ward County						
Aldridge & Stroud Inc	4	LPG	—	2500	2500	Ft Wrth D
	5	LPG	145	—	8500	Crdwll RL
	7	LPG	145	—	8500	Crdwll RL
Hatfield Drlg Co Inc	1	dsl	240	8500	10,000	Crdwll
	2	gas	140	5000	7500	Crdwll
	3	gas	145	8500	10,000	Crdwll
Hissom Drlg Co	5	gas	180	7500	10,000	Crdwll RL
C C Pollard	—	gas	150	4000	5000	Wich 61 Spdr
	—	dsl	150	5000	6000	Wich 66 Spdr
Art West Drlg Co	6	gas	145	—	8000	Crdwll RL
	8	gas	145	—	8000	Crdwll RL
Wichita County						
Ayers and Burch	1	btne	100	1500	—	Wikr-Neer
Ramey Well Serv	2	LPG	140	—	8000	Wichtex E75
Winkler County						
Bolin Oil Co & D H Bolin	8	gas	145	4500	—	Wikr-Nr S-45
R L Bob Clark Drlg Contr	3	LPG	130	3500	4500	B Erie
Donnell Drlg Co	1	gas-btne	—	5000	5000	Wichita 61
	2	gas-btne	—	5000	5000	Wichita 61
	3	gas-btne	—	5000	5000	Wichita 55
Art West Drlg Co	10	dsl	125	—	8000	Crdwll RL
Young County						
Chas E Hipp Co	12	btne	145	4000	5000	B Erie 36-L
	15	btne	145	4000	5000	B Erie 36-L
	18	btne	225	6000	9000	B Erie 48-L
Oney Drlg Co	1	gas	165	5500	—	Wichita
	2	gas	145	5500	—	Wichita
	3	gas	210	6500	—	Wichita
	4	gas	145	5500	—	Ft Wrth
UTAH						
Uintah County						
Charles M Jameson	1	gas-gaso	—	—	—	B Erie 36-L
WEST VIRGINIA						
Fayette County						
Allen Drlg Co	7	gas	175	3500	5000	Natl Mach 2
Logan County						
Allen Drlg Co	2	gas	145	5000	6000	B Erie Spddr 36-L
Marshall County						
Cecil Chisler & Son	1	gas-gaso	78	3500	3500	B Erie Spddr 28-L
Mingo County						
Allen Drlg Co	1	gas	128	5000	6000	B Erie Spddr 36-L
Nicholas County						
Allen Drlg Co	3	gas	128	5000	6000	B Erie Spddr 36-L
WYOMING						
Converse County						
Prairie Drlg Co	2	gas	190	—	10,000	Crdwll RS
	2	gas	—	—	—	Cardwell RL
Natrona County						
Morrison Drlg Co Inc (Wyo)	1	btne	145	4500	6000	Crdwll
	2	btne	185	5500	8000	Crdwll
	3	btne	185	5500	8000	Crdwll

CANADIAN DRILLING CONTRACTORS

ROTARY AND CABLE TOOLS

ALPHABETICAL LISTING

Arrow Drlg Co 201 Oil Exchange Bldg Calgary Alberta Canada
Peter Bawden Drlg Ltd 810-A First St W Calgary Alberta Canada
Bernco Drlg Ltd 507 Lancaster Bldg Calgary Alberta Canada
Big Horn Drlg Ltd 6530 100th St Edmonton Alberta Canada
Border Drlg Co Ltd Box 40 Lloydminster Alberta Canada
Brinkerhoff Drlg Co Ltd 1001 Mobil Oil Bldg Calgary Alberta Can
Brown Drlg Ltd 10509 81st Ave Edmonton Alberta Canada
Cactus Drlg Corp Ltd Box 853 Calgary Alberta Canada
Can American Drlg Ltd 320 7th Ave W Calgary Alberta Canada
Can-Tex Drlg Co Ltd 239 Sixth Ave W Calgary Alberta Canada
Cascade Drlg Co Ltd 330 Ninth Ave W Calgary Alberta Canada
Central Leduc Drlg Co Ltd 224 Ninth Ave W Calgary Alta Can
Commonwealth Drlg Co Ltd 122 8th Ave W Calgary Alberta Can
Coralta Drlg Ltd Box 4104 Edmonton Alberta Canada
Coultis Drlg Ltd 1724 Suffolk St Calgary Alberta Canada
Dallas Drlg Co Ltd 1208 First Natl Bk Bldg Dallas Tex
Deven Drlg Co Ltd 703 Fifth St W Calgary Alberta Canada
Dominion Drlg Co Ltd 401 Petroleum Bldg Edmonton Alberta Canada
Double "A" Drlg Co Ltd 709 Eighth Ave W Calgary Alberta Canada
Duke Drlg Co Ltd 239 Eighth Ave W Calgary Alberta Canada
Gardner Bros Drlg Co Inc 1718 Davis Bldg Dallas Tex
General Petroleums of Canada Ltd 224 Ninth Ave W Calgary Alberta Canada
Gustavson Drlg Co Ltd 203 Empire Bldg Calgary Alberta Canada

When it gets in your drilling mud, sand like this can eliminate profits.

Glass-hard, it cuts pump parts, bit nozzles, and bit cutters. It increases maintenance costs, decreases bit footage, increases round trips. It increases funnel viscosity, increases mud weight and complicates mud maintenance problems. Generally, it plays hob with drilling costs and profits.

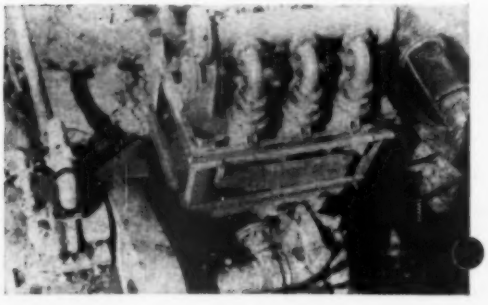
Everybody drilling through sand knows the damage it does, but the big question is how to take the sand out efficiently and economically.

There have been many efforts along this line—most of them only moderately successful.

SWACO and Dorr-Oliver, however, have developed a line of Dorrco D-Sanders that remove virtually all sand and drilled solids larger than 30 or 60 microns.

As a result of efficient performance, these units eliminate problems commonly associated with sand and drilled solids in mud.

Dorrco D-Sanders, distributed by SWACO, can be tailored to virtually any rig or drilling requirement. Write us for further information.



A size 6 D-Sander installed on a well in South Louisiana.

SALT WATER CONTROL Inc.

A Sid Richardson Development Company
1211 Ft. Worth National Bank
Phone: ED 2-4434
Ft. Worth, Texas

SWACO

Guthrie McLaren Drlg Ltd 9916 - 109 St Edmonton Alberta Canada
Hi-Tower Drlg Co Ltd 400 Lancaster Bldg Calgary Alberta Canada
Hunter Drlg Ltd 602 Seventh Ave W Calgary Alberta Canada
Jennings Drlg Co (Alta) Ltd
133 Sixth Ave SE Rm 201 Calgary Alberta Canada
Kenyon's Drlg Serv Co Ltd 10439 82nd Ave Edmonton Alta Canada
Lohmann-Johnson Drlg Co Ltd 208 Bamlett Bldg Calgary Alberta Can
L & J Drlg Co Inc 320 Indiana Bk Bldg Evansville Ind
Parker Drlg Co of Canada Ltd
409 Eighth Ave W Calgary Alberta Canada
Patterson & Culver Box 92 Dunnville Ontario Canada
Pennant Drlg Ltd 108-A Eighth Ave W Calgary Alberta Canada
Petrolia Drlg Co Ltd 2412 4th St SW Calgary Alberta Canada
Precision Drlg Co Ltd 1134 Eighth Ave W Calgary Alberta Can
Reading & Bates Drlg Co Ltd Royal Bk Bldg Calgary Alberta Can
Regent Drlg Co Ltd Box 421 Edmonton Alberta Canada
Ryland Drlg Ltd 10318 82nd Ave Edmonton Alberta Canada
S & T Drlg Co Ltd 10852 82nd St Edmonton Alberta Canada
Teton Drlg Co Ltd Box 2068 Casper Wyo
Trident Drlg Co Ltd 630 Eighth St W Calgary Alberta Canada
Trinity Canadian Drlg Co 1101 F R Webster Bldg
237 Seventh Ave W Calgary Alberta Canada
Wilrich Drlg Ltd 10584 107th St Edmonton Alberta Canada

Canadian Contract ROTARY Drilling Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALBERTA						
Cactus Drlg Corp Ltd	3	dsl	420	Natl T-32	280	6,000
Petrolia Drlg Co Ltd	7	dsl	330	Natl 50	330	7,500
	10	dsl	300	Unit U-34	300	5 400
	11	dsl	1005	Unit U-40	1005	12,000
Alahambra						
Can-Tex Drlg Co Ltd	10	—	—	Emsco J-1100	—	15,000
Beaver Lodge						
General Pet of Canada Ltd	7	dsl	1400	Natl 80-B	1300	13,000
Bellshill Lake						
Peter Bawden Drlg Ltd	12	dsl	250	Natl T-12	225	4,000
	13	dsl	175	Ideco 25	175	3,000
Big Horn Drlg Ltd	1	dsl	300	Crdwll S 350	300	5,000
Bentley						
Regent Drlg Co Ltd	28	dsl	500	Natl 50-A	520	7,000
Blood Indian Reserve						
Cascade Drlg Co Ltd	7	dsl	—	Natl 50A	—	7,500
Breton						
Arrow Drlg Co	8	dsl	250	Emsco GB-350	480	7,000
Burnt Timber Creek						
Cascade Drlg Co Ltd	14	dsl	—	Unit U-20	—	14,000
Calgary						
Devon Drlg Co Ltd	3	dsl	700	Emsco GB-500	500	9,500
General Pet of Canada Ltd	10	dsl	1400	Natl 80	1000	12,000
Reading & Bates Drlg Co Ltd	3	dsl	950	Natl 75	1050	10,000
Calmar						
Commonwealth Drlg Co Ltd	16	dsl	800	Emsco GB-350	720	7,000
Cardston						
Pennant Drlg Ltd	1	dsl	775	Unit U-40	775	11,500
Castle River						
Commonwealth Drlg Co Ltd	26	dsl	1275	Natl 80B	1410	12,000
(Central)						
Parker Drlg Co of Canada Ltd	1	dsl	615	"Oilwell" 76	750	11,000
	3	dsl	765	"Oilwell" 76	1005	12,000
	5	dsl	420	Natl 50	420	7,000
	9	dsl	765	Natl 125	1005	14,000
	12	dsl	600	"Oilwell" 66	670	9,000
	11	dsl	400	Natl 50	500	6,500
Cessford						
Precision Drlg Co Ltd	3	dsl	276	Ideco H-30	276	5,000
	4	dsl	276	Natl T-20	276	5,000
Chancellor						
Hi-Tower Drlg Co Ltd	5	dsl	350	Natl 50	450	5,000
	9	dsl	285	Crdwll D	300	5,000
Chard						
Precision Drlg Co Ltd	2	dsl	276	Ideco H-20-D	184	3,500
	8	dsl	276	Ideco H-30-D	276	4,000
Charron						
Dominion Drlg Co Ltd	4	dsl	600	Emsco GB-250	300	5,000
Cochrane						
Commonwealth Drlg Co Ltd	21	dsl	1250	Ideco 7-11	900	10,500
Duke Drlg Co Ltd	5	dsl	700	Unit U-20	1386	13,500
Coronation						
Coralta Drlg Ltd	2	gas	180	Failing 1500	180	1,500/2¾"
Drayton Valley						
Arrow Drlg Co	19	dsl	250	Emsco GB-350	480	7,000
Hi-Tower Drlg Co Ltd	4	dsl	350	Natl 50	450	6,500
S & T Drlg Co Ltd	1	dsl	520	Natl 50-A	520	8,000
	2	dsl	440	Natl T-32	270	6,000
Drumheller						
Commonwealth Drlg Co Ltd	13	dsl	630	Emsco GA-350	720	6,500
Edmonton						
Big Horn Drlg Ltd	2	dsl	250	Crdwll L	180	3,500
Commonwealth Drlg Co Ltd	3	dsl	690	Natl 50	600	6,500
	7	dsl	750	Natl 50	530	6,500
	17	dsl	630	Emsco GB-350	720	6,000
	23	dsl	905	Emsco GC-500	800	9,500
Coralta Drlg Ltd	1	gas	180	Failing 1500	180	1,500/2¾"
Kenyon's Drlg & Serv Ltd	11	dsl	—	Crdwll 151	—	5,000/3½"
Lohmann-Johnson Drlg Co Ltd	1	dsl	550	"Oilwell" 66	550	7,500
Parker Drlg Co of Canada Ltd	4	dsl	400	Natl 50	500	6,500
	6	dsl	420	"Oilwell" 52-T	420	6,500
Regent Drlg Co Ltd	3	dsl	720	Brwstr N-55	520	8,000
	26	dsl	260	Ideco H-40	260	6,000
Wilrich Drlg Ltd	6	dsl	300	Unit U-34	300	6,000
Edson						
Brinkerhoff Drlg Co Ltd	21	dsl	850	Emsco GB-800	1269	13,500
Gardner Bros Drlg Co Inc	7	dsl	850	Natl 75	1000	12,000
Pennant Drlg Ltd	6	dsl	1350	Unit U-40	1200	11,500
Trident Drlg Co Ltd	8	dsl	—	"Oilwell" 96	1920	15,000
Entrance						
Arrow Drlg Co	21	dsl	1250	Emsco J-1250	1400	14,000
Fort Assiniboine						
Regent Drlg Co Ltd	9	dsl	750	Brwstr N-75	780	10,000
Fox Creek						
Cascade Drlg Co Ltd	17	dsl	—	Natl 75		12,000
Gem						
Can-Tex Drlg Co Ltd	2	—	—	Crdwll RL	—	5,000
Gilby						
General Pet of Canada Ltd	3	dsl	425	Natl 50-A	650	7,500
Goodwin						
Commonwealth Drlg Co Ltd	19	dsl	735	Natl 50-A	790	9,500
Grande Prairie						
Duke Drlg Co Ltd	8	dsl	500	Unit U-40	670	10,000
General Pet of Canada Ltd	5	dsl	800	Natl 80-B	1000	12,000
Gustavson Drlg Co Ltd	4	dsl	850	Natl 55	850	10,000
Trident Drlg Co Ltd	10	dsl	—	Emsco GB-350	510	6,500
	12	dsl	—	Unit U-15	640	7,500
Greencourt						
Hi-Tower Drlg Co Ltd	8	dsl	570	Unit U-15	600	8,000
Harmatton						
Commonwealth Drlg Co Ltd	9	dsl	1020	Ideco 700	940	10,000
	28	dsl	920	Natl 55	1000	10,000
Hi-Tower Drlg Co Ltd	1	dsl	525	"Oilwell" 66	550	8,000
Regent Drlg Co Ltd	6	dsl	750	Brwstr N-75	780	10,000
Trident Drlg Co Ltd	7	dsl	—	"Oilwell" 76	960	10,000
Harmon Valley						
Trident Drlg Co Ltd	14	dsl	—	"Oilwell" 76	960	10,000
High River						
Hi-Tower Drlg Co Ltd	7	dsl	525	"Oilwell" 66	550	8,000
House Mountain						
Can-Tex Drlg Co Ltd	6	—	—	Emsco GA-500	—	8,000
Innisfail						
Brinkerhoff Drlg Co Ltd	1	dsl	625	Emsco GC-500	846	10,000
Can-Tex Drlg Co Ltd	5	—	—	"Oilwell" 66	—	8,000
General Pet of Canada Ltd	11	dsl	1400	Natl 80-B	1150	12,000
Hi-Tower Drlg Co Ltd	6	dsl	755	"Oilwell" 76	800	12,000
	10	dsl	755	"Oilwell" 76	800	12,000
S & T Drlg Co Ltd	3	dsl	900	Natl 55	900	9,000
Joffre						
Peter Bawden Drlg Ltd	6	dsl	722	Unit U-36A	722	8,500
Commonwealth Drlg Co Ltd	8	dsl	690	Brwstr N-7	600	8,000
Pennant Drlg Ltd	2	dsl	1155	Brwstr N-7	755	8,500
Regent Drlg Co Ltd	2	dsl	520	Brwstr N-55	520	8,000
Trident Drlg Co Ltd	9	dsl	—	"Oilwell" 76	960	10,000
	13	dsl	—	"Oilwell" 66	640	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Joseph Lake						
Big Horn Drlg Ltd	3	dsl	300	Crdwll L-350	300	4,500
Kaybob						
Peter Bawden Drlg Ltd	2	dsl	810	Natl 55	810	10,000
Can-Tex Drlg Co Ltd	3	—	—	Emsco GB-800	—	12,000
General Pet of Canada Ltd	18	dsl	1400	Natl 80-B	1150	12,000
Keystone						
Peter Bawden Drlg Ltd	1	dsl	415	Natl T-32	275	6,000
	8	dsl	300	Natl T-32	300	6,500
Brown Drlg Ltd	1	dsl	275	Crdwll S	—	5,000
Kinuso						
Can American Drlg Ltd	3	dsl	750	Natl 80-B	1645	10,000
Hi-Tower Drlg Co Ltd	3	dsl	525	"Oilwell" 66	550	8,000
Lac La Biche						
Can-Tex Drlg Co Ltd	9	—	—	Crdwll OT	—	7,000
Ladue						
Can-Tex Drlg Co Ltd	8	—	—	Natl T-25	—	5,500
Lloydminster						
Peter Bawden Drlg Ltd	14	dsl	142	Crdwll	100	2,500
Border Drlg Co Ltd	1	dsl	175	Crdwll L	150	3,500
Medicine Hat						
Bernco Drlg Ltd	1	dsl	278	Frnks SA4000A	310	4,500
Coultis Drlg Ltd	1	dsl	238	Ideco H-25-D	235	4,000
Nanton						
Arrow Drlg Co	6	dsl	250	Emsco GB-350	350	7,000
Trident Drlg Co Ltd	4	dsl	—	Natl 100	1200	13,000
Nevis						
Can-Tex Drlg Co Ltd	7	—	—	"Oilwell" 64B	—	7,500
Nordegg						
Duke Drlg Co Ltd	6	dsl	850	Unit U-20	1386	13,500
Normandville						
Gustavson Drlg Co Ltd (Northwestern)	5	dsl	420	Natl T-32	275	6,500
Parker Drlg Co of Canada Ltd	2	dsl	615	"Oilwell" 76	750	11,000
	7	dsl	600	Natl 55	670	9,000
	8	dsl	400	Natl 50	500	6,500
	10	dsl	400	Natl 50-A	500	7,000
Olds						
Pennant Drlg Ltd	4	dsl	1000	Crdwll D	650	9,500
Peace River						
Dominion Drlg Co Ltd	1	dsl	360	Natl T-32	280	5,000
	3	dsl	600	Natl T-32	320	5,000
Pembina						
Brinkerhoff Drlg Co Ltd	16	dsl	370	Emsco GA-350	450	7,500
Brown Drlg Ltd	2	dsl	550	Natl 50	550	7,500
Cascade Drlg Co Ltd	1	dsl	—	Natl 50	—	6,500
	3	dsl	—	Natl 50	—	6,500
	9	dsl	—	Natl T-32	—	5,500
	10	dsl	—	Natl 50	—	6,500
	16	dsl	250	Unit U-34	250	5,000
Commonwealth Drlg Co Ltd	10	dsl	550	Ideco H-35D	300	6,500
Duke Drlg Co Ltd	2	dsl	650	Natl 50	650	8,000
General Pet of Canada Ltd	14	dsl	350	Crdwll OA	500	6,500
Gustavson Drlg Co Ltd	1	dsl	500	Natl 50	500	7,500
	3	dsl	275	Ideco H-40	300	6,500
Reading & Bates Drlg Co Ltd	5	dsl	375	Natl 50-A	600	7,000
Regent Drlg Co Ltd	1	dsl	260	Brwstr N-4	260	6,000
	30	dsl	260	Ideco H-40	260	6,000
Ryland Drlg Ltd	1	dsl	600	Emsco 450	640	7,500
	2	dsl	670	Natl 50	690	7,500
	4	dsl	450	Emsco 350	475	7,000
Trident Drlg Co Ltd	1	dsl	—	"Oilwell" 64B	640	5,000
	3	dsl	—	"Oilwell" 64B	640	5,000
Pincher Creek						
Brinkerhoff Drlg Co Ltd	8	dsl	900	Natl 110	1200	15,000
	19	dsl	850	Emsco GA-800	1269	14,000
Regent Drlg Co Ltd	7	dsl	1200	Natl 125	1500	15,000
Red Deer						
General Pet of Canada Ltd	4	dsl	500	Natl 50-A	650	7,500
	6	dsl	500	Natl 50-A	500	7,000
Red Earth						
Commonwealth Drlg Co Ltd	11	dsl	260	Ideco H-40 D	300	5,500
Rimbey						
Brinkerhoff Drlg Co Ltd	15	dsl	370	Natl 50-A	600	8,500
Rocky Mountain House						
General Pet of Canada Ltd	16	dsl	1050	Natl 55	1150	10,000
Lohmann-Johnson Drlg Co Ltd	2	dsl	218	Unit U-15	500	8,500
St Paul						
Wilrich Drlg Ltd	2	dsl	300	Natl T-12	300	4,000/3½"
Savannah Creek						
Peter Bawden Drlg Ltd	10	dsl	600	Ideco 7-11	810	11,500
Sedgewick						
Guthrie McLaren Drlg Ltd	2	dsl	500	"Oilwell" T-52	350	7,500
Simonette Valley						
Cascade Drlg Co Ltd (Southeastern)	12	dsl	—	Natl 80B	—	14,000
Cactus Drlg Corp Ltd	4	dsl	200	Emsco GB-160	200	4,000
Sturgeon Lake						
Peter Bawden Drlg Ltd	7	dsl	720	Natl 55	720	9,500
Sundre						
Duke Drlg Co Ltd	7	dsl	850	Unit U-20	1386	13,500
General Pet of Canada Ltd	15	dsl	1400	Natl 55	1050	10,000
	17	dsl	1400	Natl 55	1050	10,000
	19	dsl	435	Natl T-32	175	5,500
Swan Hills						
Can-Tex Drlg Co Ltd	12	—	—	Emsco GB-800	—	12,000
Double-A Drlg Co Ltd	2	dsl	800	Ideco H-525	600	8,000
Sylvan Lake						
Pennant Drlg Ltd	5	dsl	900	Unit U-40	900	11,500
Taber						
Hunter Drlg Ltd	2	dsl	275	Crdwll	260	6,000
Valleyview						
Brinkerhoff Drlg Co Ltd	18	dsl	625	Emsco GC-500	846	10,000
Guthrie McLaren Drlg Ltd	1	dsl	300	"Oilwell" T-52	350	7,000
Violet Grove						
Cascade Drlg Co Ltd	8	dsl	—	Natl 50	—	6,500
Waterton						
Commonwealth Drlg Co Ltd	1	dsl	1350	Natl 110	1500	14,000
Westlock						
Wilrich Drlg Ltd	4	dsl	220	Failing 2500	220	3,000/3½"
Wetaskiwin						
Jennings Drlg Co (Alta) Ltd	1	dsl	250	Beth C-50	300	7,500
	2	dsl	250	Beth C-50	300	7,500
	3	dsl	250	Beth 55 Twstr	300	7,500
	4	dsl	360	Unit U-15	720	9,500
Whitecourt						
Arrow Drlg Co	26	dsl	975	Emsco GB-800	1200	13,000
Peter Bawden Drlg Ltd	9	dsl	1000	Unit U-40	1000	12,000
Brinkerhoff Drlg Co Ltd	22	dsl	900	Natl 110	1300	15,000
Duke Drlg Co Ltd	9	dsl	500	Unit U-15	650	8,500
Reading & Bates Drlg Co Ltd	4	dsl	950	Natl 80-B	1050	12,000
	6	dsl	800	Natl 80-B	1200	7,000
Regent Drlg Co Ltd	8	dsl	750	Brwstr N-75	780	10,000
	25	dsl	750	Brwstr N-75	780	10,000
Wimborne						
Can-Tex Drlg Co Ltd	4	—	—	Crdwll OC	—	8,000
Youngstown						
General Pet of Canada Ltd	12	dsl	250	Natl T-20	250	4,600
BRITISH COLUMBIA PROVINCE						
Alcan Highway—Mile 103						
Arrow Drlg Co	7	dsl	600	Emsco GC-500	700	9,000
Alcan Highway—Mile 142						
Reading & Bates Drlg Co Ltd	7	dsl	800	Natl 55-A	1200	12,500
Blueberry						
Brinkerhoff Drlg Co Ltd	14	dsl	370	Emsco GB-500	600	8,500
	20	dsl	370	Natl 50A	600	8,500
Trinity Canadian Drlg Co	1	dsl	995	Emsco GC-500	770	10,000
	3	dsl	720	Emsco 350	670	7,000
	4	dsl	990	Natl 80-B	990	12,000
Boundary Lake						
Commonwealth Drlg Co Ltd	15	dsl	800	Brwstr N-7	600	8,000
Dawson Creek						
Cascade Drlg Co Ltd	4	dsl	—	Natl 50A	—	7,500
	11	dsl	—	Crdwll D	—	5,500
Trinity Canadian Drlg Co	5	dsl	1250	Emsco A-800	1150	15,000
	7	dsl	875	Emsco GC-500	720	10,000
Ft Nelson						
Trident Drlg Co Ltd	6	dsl	—	Emsco 500	640	8,500
Ft St John						
Arrow Drlg Co	4	dsl	500	Emsco CB-350	500	7,000
Peter Bawden Drlg Ltd	5	dsl	440	Natl T-32	270	5,500
Cascade Drlg Co Ltd	2	dsl	—	Wisn Roadair	—	9,200
	5	dsl	—	Natl 50A	—	7,500
Commonwealth Drlg Co Ltd	20	dsl	1270	Ideco 7-11	900	10,500
	22	dsl	750	Natl 50	530	6,500
Dallas Drlg Co Ltd	1	dsl	625	Emsco GB-500	750	9,500
	2	dsl	578	Emsco GB-500	560	8,000
	3	dsl	500	Emsco GB-350	495	7,000
	4	dsl	500	Emsco GB-350	560	7,000
Devon Drlg Co Ltd	1	dsl	700	Emsco GA-500	500	9,500
	2	dsl	300	Emsco GA-350	350	7,500
Regent Drlg Co Ltd	5	dsl	720	Brwstr N-7	520	8,000
	24	dsl	720	Brwstr N-7	520	8,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Halfway River						
Dominion Drlg Co Ltd	2	dsl	580	Natl 50-A	450	6,500
Hudson Hope						
Reading & Bates Drlg Co Ltd	2	dsl	800	Natl 100	1050	12,000
MANITOBA PROVINCE						
Virden						
Peter Bawden Drlg Ltd	4	dsl	220	Crdwll RL	205	4,500
Commonwealth Drlg Co Ltd	18	dsl	260	Ideco H-25D	300	4,500
Coultis Drlg Ltd	2	dsl	245	Wisn Mogul	245	4,000
	3	dsl	200	Wgnr Mrhse TD2	200	3,500/3½"
NORTHWEST TERRITORY						
Peter Bawden Drlg Ltd	11	dsl	250	Natl T-32	300	5,000
SASKATCHEWAN PROVINCE						
Alida						
Can-Tex Drlg Co Ltd	1	—	—	Crdwll RL	—	5,000
Avonlea						
Commonwealth Drlg Co Ltd	6	dsl	690	Ideco M-750	600	7,000
Carievale						
Gustavson Drlg Co Ltd	2	dsl	500	Natl T-32	250	6,500
Carnduff						
Can American Drlg Ltd	1	dsl	350	Natl T-32	275	5,000
Commonwealth Drlg Co Ltd	4	dsl	260	Ideco H-40D	300	6,000
General Pet of Canada Ltd	21	dsl	250	Natl T-20	185	4,600
Estevan						
Commonwealth Drlg Co Ltd	14	dsl	580	Ideco H-40D	660	5,500
Hunter Drlg Ltd	1	dsl	450	Crdwll	260	6,000
	3	dsl	450	Crdwll	260	6,000
Kenyon's Drlg & Serv Ltd	12	dsl	—	Frnks Comet 658	—	5,000
L & J Drlg Co Inc	5	dsl	300	Crdwll S	440	4,500
Precision Drlg Co Ltd	6	dsl	276	Ideco H-30-D	276	5,000
	11	dsl	550	Crdwll D	550	6,000
Reading & Bates Drlg Co Ltd	1	dsl	300	Natl 50-A	700	7,000
Regent Drlg Co Ltd	4	dsl	260	Brwstr N-4	260	6,000
Frobisher						
Commonwealth Drlg Co Ltd	12	dsl	260	Natl T-32	300	5,500
Regent Drlg Co Ltd	23	dsl	260	Brwstr N-4	260	6,000
Glen Ewen						
Ryland Drlg Ltd	3	dsl	320	Natl T-32	320	6,000
Halbrite						
Cascade Drlg Co Ltd	6	dsl	—	Natl T-20	—	4,500
Hirsch						
Can American Drlg Ltd	7	dsl	260	Natl T-20	260	4,500
Kingsford						
Commonwealth Drlg Co Ltd	2	dsl	550	Natl 50	420	6,500
Kipling						
General Pet of Canada Ltd	20	dsl	275	Emsco GB250T	275	5,000
Midale						
General Pet of Canada Ltd	8	dsl	250	Natl T-25	250	5,000
Regent Drlg Co Ltd	29	dsl	260	Brwstr N-4	260	6,000
Roncott						
Regent Drlg Co Ltd	27	dsl	260	Brwstr N-4	260	6,000
(Southeastern)						
Peter Bawden Drlg Ltd	3	dsl	270	Crdwll S	180	4,500
Double-A Drlg Co Ltd	1	dsl	300	Ideco H-30	265	4,500
	3	dsl	300	Ideco H-40	265	6,000
Steelman						
Brinkerhoff Drlg Co Ltd	12	dsl	480	Natl T-32	300	6,000
Can American Drlg Ltd	5	dsl	375	Natl T-32	320	5,000
Commonwealth Drlg Co Ltd	5	dsl	260	Emsco GA-250T	310	5,000
	25	dsl	425	Unit U-34D	300	5,500
General Pet of Canada Ltd	1	dsl	250	Natl 50	525	6,500
	2	dsl	250	Unit U-34	250	4,800
Swift Current						
Precision Drlg Co Ltd	1	dsl	276	Ideco H-30-D	276	5,000
	5	dsl	276	Brwstr N-4	276	5,000
	9	dsl	276	Brwstr N-4	276	5,000
	10	dsl	550	Ideco 525-D	550	7,500
	12	dsl	276	Natl T-20	276	5,000
Regent Drlg Co Ltd	22	dsl	260	Brwstr N-4	260	6,000
Unity						
General Pet of Canada Ltd	9	dsl	375	Natl T-25	250	5,500
Weyburn						
Central Leduc Drlg Co Ltd	1	dsl	500	Natl 50	500	6,500
	2	dsl	285	Crdwll TR 66	245	5,000
Commonwealth Drlg Co Ltd	24	dsl	520	Natl 50	600	6,000
Teton Drlg Co Ltd	1	dsl	520	Emsco GB-250	360	6,500
Yellow Grass						
Can American Drlg Ltd	2	dsl	650	Natl T-55	975	7,500
Yorkton						
Can American Drlg Ltd	4	dsl	260	Natl T-20	260	4,000
	6	dsl	275	Natl T-12	260	3,000

Canadian Cable Tools

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
ONTARIO PROVINCE						
Haldimand						
Patterson & Culver	2	gas	60	1500	2000	B Erie 24-L
Norfolk						
Patterson & Culver	1	gas	80	2500	3500	B Erie 28-L
	3	gas	60	1500	2000	B Erie 24-L

SOME CONTRACT RIGS IN FOREIGN SERVICE

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALASKA						
Kenai Peninsula						
Coastal Drlg Co	3	dsl	1000	Emsco A-800	1650	13,000
Yakutat						
Haney & Williams Drlg Co	4	dsl	900	Emsco J-750	900	10,000
BRITISH HONDURAS						
Kerr-McGee Oil Ind Inc	14	dsl	695	Natl 50	630	9,000
	50	dsl	1000	Natl 55	770	10,000
COLOMBIA						
Cartagena						
Drlg & Expl Co Inc	—	dsl	—	"Oilwell" 96	1500	18,000
DENMARK						
K L Kellogg & Sons	33	gas	1750	Emsco GB-800	1050	12,000
DOMINICAN REPUBLIC						
Comet Drlg Co	2	dsl	1000	Natl 75	750	10,000
HOLLAND						
Drilvo	1	dsl	—	Natl 75	1050	9,500
	2	dsl	—	Natl 50	750	8,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
INDIA						
Southeastern Asia Drlg Co	27	dsl	1000	Natl 55	825	10,000
ITALY						
Drilvo	3	dsl	—	Natl 100	1200	13,000
Abruzzo						
Delta Overseas Drlg Co	2	dsl	260	Ideco H-30	300	4,500
Caltagirone						
Delta Overseas Drlg Co	3	dsl	500	Emsco GB-500	500	8,500
Rome						
Delta Overseas Drlg Co	1	dsl	900	Ansaldo 2000	600	7,000
Siracusa, Sicilia						
Delta Overseas Drlg Co	4	dsl	900	Emsco 800	900	11,000
JORDAN						
Parker Drlg Co	46	gas	—	Natl L-75	700	10,000
NIGERIA						
Drilvo	4	dsl	—	Natl 80-B	1500	14,000
	5	dsl	—	Natl 80-B	1500	14,000
	6	dsl	—	Natl 80-B	1500	14,000

New drawworks for faster, more efficient drilling

700 to 1200 HORSEPOWER

MID-CONTINENT U-712-A

This all-new U-712-A drawworks, rated at 700-1200 net input horsepower, incorporates many outstanding features to increase drilling speed and efficiency. Manufactured by Unit Rig & Equipment Co., a subsidiary of Mid-Continent Supply Co., the U-712-A includes these important advantages:

- **NEW** Unitized controls, conveniently located in a single console, result in greater operational efficiency.
- **NEW** Grease lubrication of bearings with flood lubrication provided for chains, sprockets and splined clutches.
- **NEW** Self-equalizing 48" diameter brakes designed for rapid, drag-free release and smooth feed-off operation.
- **NEW** Fawick VC clutches mounted on the drum shaft for low and high drives, with an emergency splined clutch provided for the low drives.

The U-712-A is designed as an integral drilling unit which includes hoisting drum, transmission, rotary drive and auxiliary brake. For complete information, write for our U-712-A Bulletin or contact your local Mid-Continent representative.

DW3-8

MID-CONTINENT SUPPLY CO.

MID-CONTINENT BUILDING • FORT WORTH, TEXAS

Export Division: 45 Rockefeller Plaza, New York 20, N. Y. Cable: MIDCUMPORT NYK

THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
PAKISTAN						
(West)						
Southeastern Asia Drlg Co	24	dsl	1200	"Oilwell" 96	1600	18,000
	26	dsl	1000	Natl 55	825	10,000
TURKEY						
Iskenderun						
Drlg & Expl Co Inc	—	dsl	—	Emsco GB-500	1050	7,500
(Southeastern)						
Drlg & Expl Co Inc	—	dsl	—	Natl 80-B	1500	14,000
VENEZUELA						
Anzoategui						
Helmerich & Payne Inc	61	dsl	—	Natl 125	—	—
	64	stm	—	Natl 34-10	—	—
	66	dsl	—	Natl 125	—	—
	68	stm	—	Natl 34-10	—	—
	69	stm	—	Natl 34-10	—	—
Barinas						
Helmerich & Payne Inc	62	dsl	—	Natl 125	—	—
	65	dsl	—	Natl 50-A	—	—
	67	dsl	—	Natl 110	—	—
Perforaciones Delta, C A (Caracas, Venezuela)	10	dsl	260	Crdwll O	450	7,500
(Eastern)						
Perforaciones Delta, C A (Caracas, Venezuela)	1	dsl	260	Ideco H-40-D	400	6,500
Perforaciones Delta, C A (Caracas, Venezuela)	2	dsl	260	Ideco H-40-D	400	6,500
Perforaciones Delta, C A (Caracas, Venezuela)	3	dsl	260	Failing 2066	—	—
Perforaciones Delta, C A (Caracas, Venezuela)	4	dsl	260	Ideco H-40-D	400	6,500
Perforaciones Delta, C A (Caracas, Venezuela)	5	stm	1200	Emsco UBLS	1690	15,000
Perforaciones Delta, C A (Caracas, Venezuela)	7	dsl	260	Ideco H-30-D	300	4,500
Gulf of Paria						
Perforaciones Delta, C A	12	dsl	1560	Emsco J-1250	1250	15,000
Lake Maracaibo						
Perforaciones Delta, C A	13	dsl	1040	Emsco J-1250	1250	15,000
	14	dsl-elec	2000	Emsco ECB	1200	15,000
	15	dsl-elec	2000	Emsco ECB	1200	15,000
	16	dsl-elec	2000	Emsco ECB	1200	15,000
Monagas						
Helmerich & Payne Inc	63	stm	—	Natl 34-10	—	—
San Silvestre						
Reading & Bates Co de Venezuela	2	dsl	1680	Natl 110	1800	15,000
(Western)						
Perforaciones Delta, C A (Caracas, Venezuela)	8	dsl	600	Emsco G-500	500	8,000
Perforaciones Delta, C A (Caracas, Venezuela)	9	dsl	1000	Emsco GB-800	900	12,000
Perforaciones Delta, C A (Caracas, Venezuela)	11	dsl	130	Natl T-12	120	2,500

U.S. OFFSHORE RIG LOCATOR

Some abbreviations. To provide the greatest amount of information in a compact listing, it is necessary to employ some abbreviations. Manufacturers' names are indicated in the introduction of the RIG LOCATOR. Here is a list of abbreviations employed in the offshore section for operators and operator groups:

Operators

Bahama Cal — Bahama California Oil Company

CATC — Continental Oil Company, The Atlantic Refining Company, Tidewater Oil Company, and Cities Service Oil Company.

CIMA — Mexican American Independent Company.

Calco — The California Company.

Cities Service — Cities Service Oil Company.

Humble — Humble Oil & Refining Company.

Hunt — Hunt Oil Company.

Kermac — Kerr-McGee Oil Industries, Inc.

M-C-N — Magnolia Petroleum Company, Continental Oil Company, and Newmont Oil Company.

Monterey — Monterey Oil Company.

Nat Gas & Oil — Natural Gas & Oil Corporation.

Phillips — Phillips Petroleum Company.

Placid — Placid Oil Company.

Pure — Pure Oil Company.

Richfield — Richfield Oil Corporation.

Shell — Shell Oil Company.

Sinclair — Sinclair Oil & Gas Company.

So Nat Gas — Southern Natural Gas Company.

Std Cal — Standard Oil Company of California.

Std Tex — Standard Oil Company of Texas.

Superior — The Superior Oil Company of California.

Texaco — The Texas Company.

CALIFORNIA

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Offshore Location—(County)	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
MAN-MADE ISLAND									
Brown Marine Drlg Co	Rig 1	Monterey-Texaco	Orange Co Seal Beach	40	dsl engine	Natl 50-A	750	750	8,000
PLATFORM-TENDER DRILLING UNITS									
Western Offshore Drlg & Expl Co	Rig A	Std Cal	Summerland	100	A C elec	Natl 80-B	1200	1700	10,000

CALIFORNIA

SELF-CONTAINED PLATFORMS

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Offshore Location—(County)	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Humble Oil & Ref Co	SM-1	Humble	Calif Area	64-243	dsl engine	Hopper	300	175	3,500
Richfield Oil Corp	"La Ciencia"	Richfield	Pt Mugu	286	dsl engine	Hopper Hoist	165	165	1,500
	"Rincon"	Richfield	Gaviata	221	dsl engine	Emsco 160	400	300	4,000

TEXAS

MOBILE DRILLING BARGES

Penrod Drlg Co	Bge 50 "W O Woodward"	Hunt	Sabine Pass	24	dsl-elec	Emsco EDES	1600	3075	20,000
Producers Drlg Co Inc	Rig 2	**	Orange	—	dsl engine	Emsco 914-A	1800	1800	17,000
Zapata Off-Shore Co	Rig 3 "Vinegarroon"	Std Tex	Galveston Blk 140	52	dsl engine	"Oilwell" 96	2080	2150	18,000

PLATFORM-TENDER DRILLING UNITS

Zapata Off-Shore Co	Rig 1 "Nola"	*	Galveston	—	dsl engine	Natl 130	1400	1850	15,000

LOUISIANA

MOBILE DRILLING BARGES

Coral Drlg Co	"Mr Arthur"	Calco	Bay Marchand Blk 2	45	dsl-elec	Brwstr N-12A	1250	2500	20,000+
C G Glasscock Drlg Co	Rig 12 "Mr Gus II"	CATC	West Delta Blk 70	138	dsl-elec	Natl 160-E	1950	3900	25,000
Humble Oil & Ref Co	Rig 47	Humble	Grand Isle Blk 16	45-60	dsl engine	Emsco GB-250TS	260	500	5,000
Kerr-McGee Oil Ind Inc	Rig 40	Pure	Eugene Is. Blk 32	15	dsl engine	Emsco J-1600	1150	1250	16,000
	Rig 44	Kermac-So Nat Gas	Ship Shoal Blk 28	20	dsl engine	Ideco Hydrair 1350-S	1550	1760	20,000
	Rig 45	Cities Service	Main Pass Blk 45	18	dsl engine	"Oilwell" 96-S	1150	1100	16,000
	Rig 46	Pure	Vermilion Blk 39	40	dsl-elec	Emsco EDA-460	1250	1250	20,000
	Rig 47	Phillips	W Cameron Blk 40	36	dsl-elec	Emsco EDA-460	1250	1250	20,000
Marine Drlg Inc	Rig 101	*	Wine Island Pass	—	dsl-elec	Emsco EDA	1600	1700	18,000
Movible Offshore Co	Rig 2	Texaco		20	dsl-elec	Natl 1625	1250	2000	20,000+
Ocean Drlg & Expl Co	"Mr Charlie"	Shell	South Pass Blk 27	40	dsl-elec	Emsco EDA	1500	1000	20,000
	"John Hayward"	Nat Gas & Oil	E Cameron Blk 9	30	dsl-elec	Emsco ECA	1200	1000	15,000
	"Margaret"	Shell	South Pass Blk 27	65	dsl-elec	Emsco EDES	1500	1000	20,000
	"St Louis"	Shell	South Pass Blk 27	30	dsl-elec	Emsco ECB	1200	1000	15,000
Penrod Drlg Co	Bge 51 "J M Woodruff"	Calco	Bay Marchand Blk 2	48	dsl-elec	Emsco EDES	1600	2450	20,000
	Bge 52 "Petrel"	Placid	Eugene Island Blk 210	83	dsl-elec	Emsco EDES	1600	2450	20,000
Rowan Drlg Co Inc	Bge 19	Calco	Bay Marchand Blk 2	21	dsl-elec	Unit U-1220-E	2250	2100	20,000
Southeastern Drlg Corp	Rig 22-Bge 8	Texaco	Marsh Isle (Southwest)	13	dsl engine	Natl	2200	1550	18,000

PLATFORM-TENDER DRILLING UNITS

Humble Oil & Ref Co	Rig 36	*	—	—	dsl engine	Emsco J-1250	1000	1000	15,000
	Rig 46	*	—	—	dsl engine	Emsco J-1400	1000	1000	16,000
	Rig 49	*	—	—	dsl engine	Emsco J-1400	1000	1000	16,000
	Rig 54	Humble	S Timbalier Blk 54	45-60	dsl engine	Ideco M-2500	1000	1000	16,000
Kerr-McGee Oil Ind Inc	Bge 16 "Kermac I"	*	St Mary Ph	—	dsl engine	Natl 100	900	900	12,500
	Rig 39 "D T IV"	*	St Mary Ph	—	dsl engine	Natl 125	1800	1200	16,000
	Rig 43 "Kermac II"	*	St Mary Ph	—	dsl engine	Emsco J-1000	1350	1730	14,000

LOUISIANA — (Continued)

PLATFORM-TENDER DRILLING UNITS — (Continued)

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Location—Designation	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
	Rig 48 "Kermac III"	*	St Mary Ph	—	dsl-elec	Emsco EDA-460	2625	2625	16,000
Llano Drlg Co	Rig 6 "Clayton G Dorn"	*	Morgan City	—	dsl engine	"Oilwell" 96	1800	2475	20,000
Loffland Bros Co	Rig 133 S-26	Calco	Main Pass Blk 69	24	dsl engine	Unit U-30	1200	1800	15,500
	Rig 148 S-25	Calco	West Delta Blk 30	—	dsl engine	Natl 34-10	2000	2521	20,000
	Rig 1 S-25	Calco	West Delta Blk 30	—	dsl engine	Natl 125	1500	1850	18,000
	Rig 95 S-22	Calco	Vermilion Blk 164	98	—	—	—	—	—
Magnolia-Continental Newmont	Rig 48-Bge 1	M-C-N	E Cameron Blk 64	38	dsl engine	Emsco JB-1250	1040	1040	16,000
Noble Drlg Co	— S-23	Calco	Bay Marchand Blk 2	51	dsl engine	—	—	—	—
	— S-21	Calco	Bay Marchand Blk 2	23	dsl engine	—	—	—	—
	— S-24	Calco	West Delta Blk 30	—	dsl engine	—	—	—	—
Penrod Drlg Co	Rig 10 "Eagle"	*	Bayou Beouf	—	dsl engine	Natl 130	1500	1520	18,000
Phillips Pet Co	Rig 40	*	Morgan City	—	dsl engine	Natl 125	1350	1200	16,000
Reading & Bates Offshore Drlg Co	"J W Bates"	CATC	Vermilion Blk 123	71	dsl engine	Natl 130	2000	3000	20,000+
	"Geo M Reading"	Shell	Eugene Island Blk 176	75	dsl engine	Natl 130	2000	3000	20,000+
Rowan Drlg Co Inc	Rig 17	*	Harvey	—	dsl engine	Natl 125	1305	2100	15,000
Southeastern Drlg Corp	Rig 12- Bge 9	*	New Orleans	—	dsl engine	"Oilwell" 96	1100	2250	16,000

SELF-CONTAINED PLATFORMS

Big Chief Drlg Co	Rig 34	*	Bayou Boeuf	—	dsl-elec	Emsco EDA-460	1600	2560	18,000
Brewster-Bartle Drlg Co	Rig 1	CATC	West Delta Blk 45	—	dsl engine	"Oilwell" 96	3300	3300	20,000
Humble Oil & Ref Co	Rig 50	Humble	Grand Isle Blk 16	45-60	dsl engine	Unit U-40	900	450	10,000
Loffland Bros Co	Rig 46	CATC	Grand Isle Blk 47	89	dsl-elec	Natl 34-10-DE	2840	1550	20,000
	Rig 62	CATC	Grand Isle Blk 47	85	dsl-elec	Natl 34-10	1500	1600	20,000
	Rig 144	Shell	Eugene Island Blk 188	85	dsl engine	Unit U-30	1500	1500	18,000
Magnolia-Continental-Newmont	Rig 57	M-C-N	W Cameron Blk 110	30	dsl engine	Natl 55	920	920	7,500
Nicklos Drlg Co	Rig 19	CATC	West Delta Blk 45	50	dsl engine	Natl 130	2250	2250	17,000
Phillips Pet Co	Rig 45	Phillips	Eugene Island Blk 129A	65	dsl-elec	Emsco ECC	1250	1250	18,000
Rimrock-Tidelands Inc	"Rimrock I"	*	Morgan City	—	dsl engine	Beth MC-950	1200	1200	16,000
	Rimrock III"	Sinclair	S Timbalier Blk 86	92	dsl-elec	Brwstr N-12A	1400	1800	18,000
	"Rimrock 14"	Sinclair	Eugene Island Blk 190	86	dsl engine	Emsco A-1500	2000	2000	18,000
	"Rimrock 15"	Sinclair	Eugene Island Blk 175	86	dsl engine	Brwstr N-12A	2000	2000	18,000
Rowan Drlg Co Inc	Rig 11	CATC	Grand Isle Blk 40	—	dsl engine	Unit U-1220	2400	2250	20,000
Shell Oil Co	Rig 10	Shell	W Cameron Blk 192	70	dsl engine	Natl 125	1200	1200	12,000
Shoreline Drlg Co Inc	Rig 7	CATC	Grand Isle Blk 48	92	dsl engine	Unit U-1220	2400	2400	20,000
The Superior Oil Co of Calif	Rig 27	Superior	W Cameron Blk 71	48	dsl engine	Natl 125	900	900	12,500
	Rig 20	Superior	Vermilion Blk 76	21	dsl engine	Natl 125	900	900	12,500
Southeastern Drlg Corp	Rig 23	*	Morgan City	—	dsl engine	"Oilwell" 96	1560	1560	14,000
	Rig 25	*	Morgan City	—	dsl engine	Natl 130	1560	1040	16,000

*Reported Idle June 1, 1958.
**Under Construction.

FOREIGN LOCATIONS

MOBILE DRILLING BARGES

Ocean Drlg & Expl Co	"El Dorado"	CIMA	Coast of Mexico	—	dsl-elec	Emsco EDES	1500	1000	20,000
Zapata Off-Shore Co	Rig 2 "Scorpion"	Bahama Cal	Cay Sal Bk	30	dsl engine	"Oilwell" 96	1850	1850	16,000

SELF-CONTAINED PLATFORMS

Southeastern Drlg Corp	Rig 7	—	Iran	—	dsl engine	"Oilwell" 96	1560	1040	14,000

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Houston, Texas

A DIVISION OF MISSISSIPPI RIVER FUEL CORPORATION

U. S. Well Servicing Contractors

Alphabetical Listing

A

Adams Prod Serv 2 Monte Vista Dr Bakersfield Calif
C N Adkisson Jr Box 875 McCamey Tex
Albright Well Serv Co Box 1192 Hobbs N M
Aldridge & Stroud Inc Box 962 Odessa Tex
Arrow Well Serv Box 1138 Winters Tex
Bill Atchley Box 8 Seymour Tex
Atlas Well Serv Box 1032 Duncan Okla

B

B & B Oil Well Serv Box 6 Oil City La
B & B Well Serv Co Box 321 Salem Ill
B H B Superior Well Serv Inc Box 5 Denver City Tex
Baggett Drlg Co 4305 University Dr Wichita Falls Tex
W E Barnett N Union St Brookhaven Miss
Barry Well Drlg Co West Star Rt Fallon Nev
Bateman & Whitsitt Inc Box 1956 Hobbs N M
Beckman Inc Box 1524 Muskogee Okla
Best Well Serv Box 338 Fillmore Calif
Bice Drlg Co 1310 N Ellison Guymon Okla
J W (Johnny) Birdwell Well Serv Box 201 Kamay Tex
Bivin & Smoot Drlg Co Box 147 Overton Tex
Blackwell & Sunde Co 3135 Cherry Ave Long Beach 7 Calif
Bradshaw's Oil Well Serv Box 1346 McCamey Tex
James R Brown Well Serv 1901 Florence St Kilgore Tex

C

C & C Oil Field Serv Co Box 191 Oil City La
C B S Workover Co 1713 N Esperson Bldg Houston Tex
Cactus Well Serv Box 222 Snyder Tex
Calhoun Well Serv Box 466 Aspermont Tex
Camden Drlg Co Box 1418 Corpus Christi Tex
Capitol Well Serv Co Box 4281 Oklahoma City 9 Okla
Carpenter Bros Well Serv Carpenter Bros Swabbing Inc Box 7092 Corpus Christi Tex
R L Carpenter Box 452 Sapulpa Okla
Carter-Jones Drlg Co Inc Box 1597 Kilgore Tex
Carter Well Serv Box 178 Pettus Tex
Chambless-Rosen Drlg Co Box 4294 Oklahoma City 9 Okla
Chandler Well Serv Co Box 231 El Reno Okla
M Chenirs Oil Well Serv Box 273 Norphlet Ark
Cleaveland Well Serv Box 308 Luling Tex
Clinch Drlg Co Box 27 Hazelhurst Miss
Cook's Well Serv Inc 3118 S Third Abilene Tex
Copeland & Fuller Well Serv Box 237 Kenedy Tex
Cren & Gracey Corp 1100 Houston Club Bldg Houston Tex

D

Dawson Well Serv Box 72 Charlotte Tex
Deep Well Serv Co Inc 3218 Cheryl St Wichita Falls Tex
Denver Drlg Corp Box 669 Odessa Tex
Devonian Well Serv Box 2821 Odessa Tex
Douglas V Downing Well Serv Box 206 Devine Tex
Drlg & Prod Co 2907 L Bakersfield Calif

E

E & O Well Serv Co Inc Box 3066 Odessa Tex
Eichler Well Serv Box 515 Jacksboro Tex
Errol Elkins Drlg Co 460 Rio Grande St Eagle Pass Tex
Dood Emerson Well Serv & Gen Contrg 1328 S Broadway Sulphur Springs Tex

F

Fish Oil Well Serv Box 809 Beeville Tex
Joe Flower Well Serv Co Box 14283 Houston 21 Tex
Forsan Well Serv Box A-584 Forsan Tex
J W Frazier Box 247 Aspermont Tex
French Drlg & Well Serv Box 190G Rt 1 Houston Tex

G

General Prod Serv Inc Box 442 Bakersfield Calif
Gibson Drlg Co Box 1540 Kilgore Tex
Glenn Gillespie & Sons Box 907 Cushing Okla
Glenn Drlg Co 38 Kennedy Bldg Tulsa Okla
Goldsmith Well Serv Inc Box 151 Goldsmith Tex
Graham Bros Oil Well Serv Box 80 Brookhaven Miss
J P Graham Box 1307 Bay City Tex

H

Hamlin Well Serv Box 355 Hamlin Tex
Harrison Well Serv Box 21 Denver City Tex
Win Hawkins Drlg Co 373 San Jacinto Bldg Houston 2 Tex
Odell Herring Well Serv Inc Box 401 Lindsay Okla
Hoffman Oil Well Serv Co 415 NW 11th St Seminole Tex

J

Joe's Well Serv Box 612 Smackover Ark
Johnson Drlg & Serv Co 207 McAlester Bldg Magnolia Ark
Lloyd Jones Drlg Co 700 Oil & Gas Bldg Wichita Falls Tex
Justrite Serv Co 709 Houston Club Bldg Houston Tex

K

K B M Serv Inc Box 1338 Williston N D
Keeney Well Serv Co Box 44 Pleasanton Tex
Kent Well Serv Co Box 667 Eldorado Kans
C E Knight & Co Box 1688 Snyder Tex

L

Line Oil Well Serv Co Box 4447 Oklahoma City Okla
Locke Well Serv Box 312 Royalty Tex

M

M & B Well Serv Box 963 Kermit Tex
Mac Drlg Co Box 2972 Houston Tex
Maxwell Well Serv Co Box 475 New London Tex
Miller & Co Rt 1 Overton Tex
Miller's Well Serv Co 19142 Huntington Ave Huntington Beach Calif
Mills Drlg Co Box 871 Seminole Okla
Mohawk Oil Well Serv Box 1454 Alice Tex
Morrison Drlg Co Inc Box 583 Casper Wyo

Mc

McAlister Well Serv 1610 E Scott Wichita Falls Tex

N

N & L Drlg Co Box 899 Ardmore Okla
Nelson Well Serv Co Box 899 Ardmore Okla
Nichols & Freeman Well Serv Box 183 Grandfalls Tex

O

Oil Well Serv Co 2405 Orange Ave Long Beach 6 Calif

P

Payne Bros Drlg Co 1411 10th St Lawrenceville Ill
Penick Bros Casing Pulling Co Box 5174 Midland Tex
Perforaciones Delta C A Apartado 9138 Caracas Venezuela
Permian Well Serv Inc Box 37 Wink Tex
Louis Pitcock Drlg Co Box 25 Graham Tex
Ponca Drlg Inc Drawer 784 Ponca City Okla
Pool Well Serv Co Box 1940 San Angelo Tex
Potter Bros 210 JSY Bldg Kilgore Tex
W R (John) Potter Box 14 Kamay Tex
Prairie Drlg Co Box 2068 Casper Wyo
Price-Caudle Well Serv Inc Box 453 Seminole Okla
Price-Sitton Drlg Co 406 Lubbock Natl Bk Bldg Lubbock Tex
Production Maintainers 2412 Clarinda Wichita Falls Tex

Q

Quad Drlg Co Box 974 Ardmore Okla

R

R & R Well Serv Co Box 597 Nocona Tex
Risher Well Serv Co Liberty Rd Natchez Miss
Rocket Well Serv 1706 Hill St Alvin Tex
Ross Const & Well Serv Box 278 Nocona Tex

S

Scott's Well Serv Rural Rt 4 Hwy 9 E Seminole Okla
Signal Oilfield Serv Inc 415 Petroleum Club Bldg Denver Colo
Skinner & McDougal Drlg Co Box 8774 Oklahoma City Okla
Slater Well Serv 804 Lawndale Ave Victoria Tex
Phillip Slimer Well Serv Box 326 Midland Tex
Smallwood & Son 3657 E Kiest Blvd Dallas Tex
Smith & Breyer Suite 154 Meadows Bldg Dallas 6 Tex
Darrell W Smith Co Box 1105 Midland Tex
K Smith Cable Tools 1801 Van Buren Great Bend Kans
Spears Well Serv Co Box 3187 Victoria Tex
Spur Well Serv Co Box 1325 Houston Tex
Steitle Well Serv 1312 Southwood Dr Alice Tex
Stroube Drlg Co Box 730 Corsicana Tex
Sutton Producing Co Box 6446 San Antonio Tex

T

T & H Well Serv Co 235 N 2nd St Eunice La
Terminal Drlg & Prod Co 2975 Wilshire Blvd Suite 423 Los Angeles 5 Calif
Texas Swabbing Co Box 1571 Longview Tex
Texas Workover & Oilwell Serv Co Box 32 Liberty Tex
J R Todd Co Inc Box 168 Odessa Tex
Twinoak Drlg Co 210 So Morton Okmulgee Okla

U

Universal Oilwell Serv Inc Box 1092 Snyder Tex

V

Varner Oil Well Serv Box 253 Royalty Tex
Veeder Supply & Dev Co Box 201 Cherryvale Kans

W

W & C Well Serv 306 E Florida St Delhi La
W L B Drlg Co 6635 Chocolate Bayou Road Houston Tex
W M & W Well Serv Co Box 931 Alice Tex
Well Serv Co of Crane 111 N Gaston St Crane Tex
Well Serv Inc 1901 E Virginia Ave Victoria Tex
Art West Drlg Co 205 O'Michael Bldg Odessa Tex
Chet Whaley Well Serv Co Inc 6006 Milart St Houston 21 Tex
White Well Serv Box 356 Monahans Tex
J C Williams Well Serv Co 603 S Arkansas Springhill La
Williams Well Serv Box 313 Stephens Ark
Williamson Well Serv Inc Box 3828 Odessa Tex
Winnsboro Well Serv Box 102 Winnsboro Tex
Wyoming Well Serv Inc Box 350 Cody Wyo

U. S. Contract Well Servicing or Pulling Units

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity — Swabbing	Estimated Capacity — Pulling	Can Unit Also Drill?
ARKANSAS							
Norphlet							
M Cheairs Oil Well Serv	2	Wlsn Spr	Truck	1	—	5,000/2½"	Yes
	3	Wlsn Master	Truck	1	—	3,500/2½"	Yes
	4	Cooper	Truck	1	—	10,000/2½"	No
	5	Vickers	Truck	1	—	2,500/2½"	No
Smackover							
Joe's Well Serv	1	Crdwll H-1000	Truck	1	—	5,500/2" 5,000/2½"	No
	2	Frnks 5000	Truck	1	—	8,500/2" 8,000/2½"	No
	3	Cooper	Truck	1	8,500	—	No
Stephens							
Williams Well Serv	1	Wlsn Spr	Truck	1	8,000	8,000/2" 6,000/2½" 5,000/3"	Yes
	2	Cooper	Truck	2	9,000	10,000/2" 8,000/2½" 6,500/3"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
CALIFORNIA							
Bakersfield							
Adams Prod Serv	1	Wlsn Spr Trcr	Trailer	2	10,000	11,500/2" 8,500/2½" 6,000/3"	Yes
General Prod Serv Inc	3	Hopper G	Truck	2	6,000	6,000/2" 4,000/2½" 3,000/3"	No
	7	Ideco 30	Trailer	2	10,000	10,000/2" 7,500/2½" 6,000/3"	No
	9	Hopper GTA	Truck	2	10,000	10,000/2" 7,500/2½" 6,000/3"	No
	11	Hopper GTA	Truck	2	13,000	15,000/2" 12,000/2½" 10,000/3"	No
Oil Well Serv Co	1-A	Ideco 40	Trailer	2	13,000	13,000/2½" 10,000/3"	Yes
	2-A	Ideco 40	Trailer	2	13,000	13,000/2½" 10,000/3"	Yes
	4	Wlsn Winch	Truck	2	4,000	4,000/2½" 3,500/3"	—
	11	Ideco 30	Trailer	2	10,000	10,000/2½" 8,000/3"	Yes
	12	Crdwll	Trailer	2	5,000	5,000/2½" 4,000/3"	—
	15	Ideco 30	Trailer	2	13,000	13,000/2½" 8,000/3"	Yes
Fillmore							
Best Well Serv	1	Ideco H-35	Truck	2	12,000	20,000/2" 15,000/2½" 14,000/3"	Yes
	2	Wgnr Mrhse M-100	Truck	2	12,000	20,000/2" 15,000/2½" 14,000/3"	Yes
Huntington Beach							
Miller's Well Serv Co	1	Allis Chmrs UM-40	Truck	2	4,500	5,500/2" 4,500/2½" 3,000/3"	No
	2	Allis Chmrs E-563	Truck	2	6,500	7,000/2" 5,000/2½" 3,500/3"	Yes
	3	Natl	Trailer	2	10,000	10,000/2" 8,000/2½" 6,000/3"	Yes
	4	Frnks	Truck	2	12,000	15,000/2" 10,000/2½" 7,500/3"	Yes
	5	Crdwll	Truck	2	6,500	10,000/2" 6,500/2½" 4,000/3"	Yes
	6	Frnks	Truck	2	12,000	17,000/2" 12,000/2½" 8,500/3"	Yes
Kernan							
Oil Well Serv Co	1	Ideco 30	Trailer	2	10,000	10,000/2½" 7,000/3"	Yes
	4-A	Ideco 30	Trailer	2	10,000	10,000/2½" 7,000/3"	Yes
	41	Ideco 30	Trailer	2	10,000	10,000/2½" 7,000/3"	—
	57	Ideco 30	Trailer	2	13,000	13,000/2½" 8,000/3"	Yes
Long Beach							
Blackwell & Sunde Co	1	Wgnr Mrhse 1540	Trailer	2	12,200	14,000+/2" 12,500/2½" 9,500/3"	No
	2	Wgnr Mrhse 1540	Trailer	2	12,200	14,000+/2" 12,500/2½" 9,500/3"	No
	3	Ideco H-30-AD	Trailer	2	12,200	14,000+/2" 12,500/2½" 9,500/3"	Yes
	4	Wlsn CT 25SP	Trailer	2	12,200	14,000+/2" 12,500/2½" 9,500/3"	No
	5	Ideco TJ 440	Trailer	2	12,200	14,000+/2" 12,500/2½" 9,500/3"	Yes
	6	Crdwll RL-319	Truck	2	10,000	12,000+/2" 10,000/2½" 8,000/3"	No
	7	Crdwll RL-319	Truck	2	10,000	12,000+/2" 10,000/2½" 8,000/3"	No
	8	Crdwll KLGMD	Truck	2	8,000	8,000+/2" 5,000/2½" 4,000/3"	No
Oil Well Serv Co	2	Wlsn Mogul	Truck	1	—	12,000/2½" 6,500/3"	Yes
	3	Ideco	Truck	2	13,000	13,000/2½" 7,000/3"	Yes
	5	Ideco	Trailer	2	5,000	5,000/2½" 4,000/3"	Yes
	6	Crdwll	Truck	2	10,000	7,000/2½" 6,500/3"	—
	7	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
	8	Wlsn	Truck	2	6,500	6,500/2½" 4,500/3"	—
	9	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
	14	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
Wheeler Ridge							
Drlg & Prod Co	3	Ideco Rambler	Trailer	2	7,500	5,500/2" 5,000/2½" 4,500/3"	No
Wilmington							
Terminal Drlg & Prod Co	10	Ideco Rambler	Truck	2	13,000	11,500/2½"	Yes
	11	Frnks 65-44	Truck	2	12,000	10,745/2½"	No
	13	Ideco H-30	Truck	2	11,000	9,420/2½"	No
	15	Ideco	Truck	2	12,000	10,600/2½"	Yes
	16	Wlsn	Truck	2	15,000	15,000/2½"	No
	19	Ideco H-30	Truck	2	13,500	13,400"2½"	Yes
	22	Crdwll RL	Truck	2	10,000	10,000/2½"	Yes
	23	Crdwll HL	Truck	2	7,200	5,000/2½"	No
COLORADO							
Sterling							
Signal Oilfield Serv Inc	2	Frnks 658/44	Truck	2	10,000	—	Yes
ILLINOIS							
Salem							
B & B Well Serv Co	—	Wlsn Sr	Truck	2	—	5,000/2" 5,000/2½" 4,500/3"	Yes
	—	Crdwll	Truck	1	—	4,600/2" 4,600/2½" 2,500/3"	No
KANSAS							
Arkansas City							
Kent Well Serv Co	—	Cooper	Truck	2	5,000	6,500/2" 5,500/2½" 4,800/3"	No
	—	Cooper	Truck	8	3,800	4,000/2" 3,500/2½" 3,000/3"	No
LOUISIANA							
Delhi							
W & C Well Serv	1	Wichtex C-60-HD	Truck	2	6,000	7,000/2" 5,000/2½"	Yes
	2	Wichtex C-60-HD	Truck	2	6,000	7,000/2" 5,000/2½"	Yes
	3	Wichtex C-60-HD	Truck	2	6,000	7,000/2" 5,000/2½"	Yes
Eunice							
T & H Well Serv Co	3	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	5	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	16	Wlsn Spr	Truck	1	12,000	—	No
	18	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	20	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	25	Wlsn Spr	Truck	1	12,000	—	No
	30	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	39	Wlsn Spr	Truck	1	10,000	—	No
	40	Wlsn Spr	Truck	1	12,300	—	No

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Oil City							
B & B Oil Well Serv	1	—	Truck	2	2,500	2,750/2" 2,500/2½"	No
	2	—	Truck	1	2,500	2,000/2" 2,000/2½"	No
C & C Oil Field Serv Co	1	Wlsn Sr	Truck	2	5,000	5,000/2" 4,000/2½" 3,000/3"	No
	2	Wlsn Sr	Truck	2	5,000	5,000/2" 4,000/2½" 3,000/3"	No
	3	Wlsn Sr	Truck	1	—	5,000/2" 4,000/2½" 3,000/3"	No
	4	Wlsn Sr	Truck	1	—	5,000/2" 4,000/2½" 3,000/3"	No
	5	Wlsn Sr	Truck	1	—	5,000/2" 4,000/2½" 3,000/3"	No
	6	Wlsn Sr	Truck	1	—	5,000/2" 4,000/2½" 3,000/3"	No
Springhill							
J C Williams Well Serv Co	1	Wlsn Sr	Truck	1	—	3,100/2½"	No
	2	Wlsn Spr	Truck	1	6,000	—	No
	4	Wlsn Spr	Truck	1	—	7,500/2½"	Yes
	5	Wlsn Spr	Truck	2	10,000	7,500/2½"	Yes
	7	Wlsn Spr	Truck	1	10,000	—	No
	8	Wlsn Spr	Truck	1	—	8,500/2½"	No
MISSISSIPPI							
Bolton							
Graham Bros Oil Well Serv	3	Wlsn Spr	Truck	1	—	12,000/2" 10,000/2½" 8,000/3"	No
Brookhaven							
W E Barnett	1	Wlsn Spr	Truck	1	7,000	11,000/2" 11,000/2½"	No
	2	Wlsn Spr	Truck	1	—	11,000/2" 11,000/2½"	No
	3	Wlsn Spr 38	Truck	1	—	11,000/2" 11,000/2½"	No
Graham Bros Oil Well Serv	1	Wlsn Spr	Truck	—	13,000	—	—
	3	Crdwll K	Truck	1	—	15,000/2" 13,500/2½" 10,000/3"	No
Natchez							
Risher Well Serv Co	1	Wlsn Spr 38	Truck	1	10,000	11,000/2" 9,500/2½"	Yes
	2	Wlsn Spr	Truck	1	7,500	7,000/2" 6,000/2½"	Yes
	3	Wlsn Mogul	Truck	1	11,000	—	No
MONTANA							
Glendive							
K B M Well Serv Inc	3	Crdwll H	Truck	1	7,500	6,500/2" 5,000/2½"	No
	5	Wlsn Mogul 42	Truck	1	15,000	15,000/2" 12,000/2½"	No
	8	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
Signal Oilfield Serv Inc	10	Frnks 658/65	Truck	2	12,000	—	Yes
	14	Frnks 658/65	Truck	2	10,000	—	No
NEW MEXICO							
Farmington							
Bivin & Smoot Drlg Co	3	Frnks Rocket	Truck	2	10,000	10,000/2" 10,000/2½" 7,500/3"	Yes
Signal Oilfield Serv Inc	6	Frnks 65/44	Truck	2	8,000	—	Yes
Hobbs							
Albright Well Serv Co	4	Frnks 65	Truck	1	11,000	10,000/2"	Yes
	5	Frnks 65	Truck	1	11,000	10,000/2"	Yes
	12	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½"	Yes
	17	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½"	Yes
	23	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½"	Yes
	27	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½"	Yes
	34	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½"	Yes
Bateman & Whitsitt Inc	1	Crdwll K	Truck	1	11,000	—	No
	10	Hopper GXFA	Truck	2	15,000	15,000/2" 12,500/2½" 9,000/3"	No
	15	Frnks 653	Truck	2	15,000	15,000/2" 12,500/2½" 9,000/3"	No
	20	Frnks 658	Truck	2	15,000	15,000/2" 12,500/2½" 9,000/3"	No
	25	Frnks 7000	Truck	1	—	15,000/2" 12,500/2½" 9,000/3"	No
	30	Frnks 653	Truck	2	13,500	15,000/2" 12,500/2½" 9,000/3"	No
	35	Frnks 658	Truck	2	13,500	15,000/2" 12,500/2½" 9,000/3"	No
	40	Frnks 653	Truck	2	13,500	15,000/2" 12,500/2½" 9,000/3"	No
	45	Hopper GXFA	Truck	2	15,000	15,000/2" 12,500/2½" 9,000/3"	No
	50	Hopper GXFA	Truck	2	15,000	15,000/2" 12,500/2½" 9,000/3"	No
NORTH DAKOTA							
Keene							
K B M Well Serv Inc	4	Wlsn Mogul 42	Truck	1	15,000	15,000/2" 12,000/2½"	No
	6	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
	7	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
	10	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
Tioga							
K B M Well Serv Inc	1	Frnks 658 DTM2	Truck	2	13,500	15,000/2" 12,000/2½"	No
	2	Frnks 658 DTM2	Trucks	2	13,500	15,000/2" 12,000/2½"	No
	9	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
	11	Wlsn Spr 38	Truck	2	13,500	15,000/2" 12,000/2½"	No
OKLAHOMA							
Chandler							
Chandler Well Serv Co	101	Frnks 44DTM	Truck	1	5,500	8,500/2" 6,500/2½"	No
	107	Frnks 44DTM	Truck	2	6,000	8,500/2" 6,500/2½"	Yes
	126	Frnks 44DTM	Truck	2	6,000	8,500/2" 6,500/2½"	Yes
Lindsay							
Odell Herring Well Serv Inc	2	Frnks 658	Truck	1	13,500	—	No
	3	Frnks 658	Truck	2	13,500	12,000/2" 12,000/2½"	No
	4	Frnks 658	Truck	2	13,500	12,000/2" 12,000/2½"	No
	5	Frnks 658	Truck	2	13,500	12,000/2" 12,000/2½"	No
	11	Frnks Rocket	Truck	2	13,500	16,000/2" 14,000/2½"	Yes
Okemah							
Skinner & McDougal Drlg Co	1	Allis Chmrs	Truck	1	4,500	—	No
Oklahoma City							
Capitol Well Serv Co	1	Crdwll K-200	Trailer	2	10,000	10,000/2½"	Yes
	2	Crdwll B	Truck	1	12,000	10,000/2½"	No
	2	Frnks 650	Trailer	1	10,000	10,000/2½"	No
	3	Frnks 658	Truck	2	10,000	10,000/2½"	No
Ponca City							
Ponca Drlg Inc	—	Crdwll	Truck	1	—	3,500/2" 3,000/2½" 2,500/3"	No
Sapulpa							
R L Carpenter	1	Cooper W	Truck	1	3,000	3,000/2" 2,500/2½" 2,000/3"	No
Kent Well Serv Co	—	Cooper	Truck	2	3,500	4,000/2" 3,500/2½" 3,000/3"	No

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity: Swabbing	Estimated Capacity: Pulling	Can Unit Also Drill?
	—	Cooper	Truck	7	3,800	4,000/2" 3,500/2½" 3,000/3"	No
Seminole							
Mills Drlg Co	U-1	Crdwll K-203	Truck	2	10,000	12,000/2" 12,000/2½"	—
	U-2	Crdwll K-203	Truck	2	10,000	12,000/2" 12,000/2½"	—
Price-Caudle Well Serv Inc	1	Frnks 65	Truck	1	—	10,000/2" 10,000/2½" 10,000/3"	No
	2	Frnks 44	Truck	2	8,000	10,000/2" 10,000/2½" 10,000/3"	Yes
	3	Frnks 44	Truck	2	8,000	10,000/2" 10,000/2½" 10,000/3"	Yes
Scott's Well Serv	6	Frnks DTM-658	Truck	2	12,000	12,000/2½"	No
	7	Frnks TM-44	Truck	1	—	8,000/2½"	No
	8	Frnks TM-44	Truck	1	—	6,000/2½"	No
	9	Frnks DTM-44	Truck	2	8,000	6,000/2½"	No
	10	Frnks TM-44	Truck	1	—	6,000/2½"	No
		TEXAS					
Abilene							
Cook's Well Serv Inc	—	Wichtex 57	Truck	2	7,500	7,500/2"	No
	—	Wichtex	Truck	2	7,500	7,500/2"	No
Alice							
Mohawk Oil Well Serv	2	Wisn Spr	Truck	2	10,000	9,000/2" 7,500/2½" 6,500/3"	Yes
	3	Wisn Spr	Truck	2	10,000	9,000/2" 7,500/2½" 6,500/3"	Yes
	4	Wisn Spr	Truck	2	10,000	9,000/2" 7,500/2½" 6,500/3"	Yes
	6	OCS	Truck	1	8,000	—	—
W M & W Well Serv Co	1	Wisn Spr	Truck	2	7,000	7,000/2" 6,000/2½" 5,000/3"	Yes
	2	Allis Chmrs	Truck	2	8,000	10,000/2" 10,000/2½"	Yes
	3	Wisn Spr	Truck	2	6,500	6,000/2" 5,000/2½"	Yes
	5	Wisn Spr	Truck	2	7,500	6,500/2"	Yes
	7	Wisn 38	Truck	2	8,500	8,800/2" 7,500/2½"	Yes
	9	Wisn Spr	Truck	2	8,500	8,588/2" 7,000/2½"	Yes
Alvin							
Rocket Well Serv	1	Frnks 65 TM	Truck	1	—	9,500/2"	Yes
Andrews							
Pool Well Serv Co	12	Wisn Spr 38	Truck	2	12,000	10,000/2½"	No
	19	Wisn Spr	Truck	1	10,000	—	—
	30	Wisn Spr 38	Truck	2	12,000	14,000/2½"	No
Williamson Well Serv Inc	18	Frnks 658	Truck	2	13,500	13,500/2½"	No
	19	Frnks 658	Truck	2	13,500	13,500/2½"	No
	20	Frnks 658	Truck	2	13,500	13,500/2½"	No
	21	Frnks 658	Truck	2	13,500	13,500/2½"	No
	26	Frnks 658	Truck	2	13,500	13,500/2½"	No
	33	Frnks 658	Truck	2	13,500	13,500/2½"	No
	37	Frnks 658	Truck	2	13,500	13,500/2½"	No
Aspermont							
Calhoun Well Serv	1	Wisn Spr	Truck	2	9,000	8,000/2" 7,000/2½" 5,000/3"	Yes
	2	Wisn Spr	Truck	2	9,000	8,000/2" 7,000/2½" 5,000/3"	Yes
	3	Cooper	Truck	2	8,000	7,000/2" 6,000/2½" 4,000/3"	—
Bay City							
J P Graham	12	Wisn Spr	Truck	1	9,000	—	No
	18	Wisn Spr	Truck	1	9,000	—	No
	26	Wisn Spr	Truck	1	10,000	—	No
Beeville							
Fish Oil Well Serv	1	Wisn Spr	Truck	1	—	7,500/2" 6,000/2½"	No
	2	Ideco	Truck	1	8,000	—	No
	3	Wisn Spr 38	Truck	2	9,500	10,000/2" 10,000/2½"	Yes Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity: Swabbing	Estimated Capacity: Pulling	Can Unit Also Drill?
Big Lake							
Pool Well Serv Co	1	Wisn Spr	Truck	2	10,000	8,000/2½"	No
	5	Wisn Spr	Truck	2	10,000	8,000/2½"	No
	6	Wisn Spr	Truck	1	10,000	—	No
	11	Wisn Spr 38	Truck	2	12,000	10,000/2½"	No
	14	Wisn Spr 38	Truck	2	12,000	10,000/2½"	No
	21	Wisn Spr	Truck	2	10,000	8,000/2½"	No
	24	Wisn Spr	Truck	1	10,000	—	No
	31	Frnks	Truck	2	12,000	14,000/2½"	No
Big Spring							
Forsan Oil Well Serv	183	Frnks 658DTM	Truck	2	12,000	13,000/2½"	Yes
Bryson							
Eichler Well Serv	4	Wichtex C-60	Truck	2	5,000	5,000/2"	No
	5	Wichtex C-65	Truck	2	6,000	6,000/2"	No
Charlotte							
Dawson Well Serv	1	Wisn Spr	Truck	2	9,500	10,000/2" 7,000/2½" 5,000/3"	Yes
	2	Wisn Sr	Truck	2	6,500	6,500/2" 4,500/2½" 3,500/3"	Yes
	3	Wisn Spr	Truck	2	9,500	10,000/2" 7,000/2½" 5,000/3"	Yes
Chico							
Ross Const & Well Serv	5	Wichtex	Truck	2	8,000	—	No
Colorado City							
W & C Well Serv	4	Wisn Spr 38S	Truck	2	10,000	10,000/2" 8,000/2½"	Yes
	5	Wisn Spr 38S	Truck	2	10,000	10,000/2" 8,000/2½"	Yes
	6	Wisn Spr 38S	Truck	2	10,000	10,000/2" 8,000/2½"	Yes
Conroe							
Spur Well Serv Co	2	Frnks 65-TD	Truck	1	—	8,000/2½"	Yes
Corpus Christi							
Carpenter Bros Well Serv Carpenter Bros Swabbing Inc	1	Cooper	Truck	1	10,000	—	No
Crane							
J R Todd Co Inc	4	Crdwll AL	Truck	2	9,000	8,000/2" 6,000/2½" 4,500/3"	No
	7	Crdwll K-200	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	Yes
	8	Crdwll K-200	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	Yes
	9	Crdwll K-200	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	Yes
Well Serv Co of Crane	1	Hopper G	Truck	2	13,500	15,000/2" 13,000/2½" 12,000/3"	No
	2	Hopper G	Truck	2	13,000	15,000/2" 13,000/2½" 12,000/3"	No
	3	Hopper G	Truck	2	13,000	15,000/2" 13,000/2½" 12,000/3"	No
	4	Hopper G	Truck	2	13,000	15,000/2" 13,000/2½" 12,000/3"	No
	5	Hopper G	Truck	2	13,000	15,000/2" 13,000/2½" 13,000/2½" 12,000/3"	No
	6	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½" 8,000/3"	No
	7	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½" 8,000/3"	No
	8	Hopper	Truck	2	15,000	15,000/2" 13,000/2½" 12,000/3"	Yes
Williamson Well Serv Inc	15	Frnks 658	Truck	2	13,500	13,500/2½"	No
	16	Frnks 658	Truck	2	13,500	13,500/2½"	No
	35	Frnks 658	Truck	2	13,500	13,500/2½"	No
Denver City							
B H B Superior Well Serv Inc	2	Cooper A142-42	Truck	2	13,000	14,000/2" 12,500/2½" 11,000/3"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
	3	Cooper A142-42	Truck	2	13,000	14,000/2" 12,500/2½" 11,000/3"	Yes
	5	Cooper T420-48	Truck	2	14,000	16,000/2" 13,500/2½" 12,000/3"	Yes
Harrison Well Serv	1	Wlsn Mogul	Truck	2	14,000	12,000/2½"	—
	2	Wlsn Mogul	Truck	2	14,000	12,000/2½"	—
Philip J Slimer Well Serv	1	Frnks	Truck	2	12,000	15,000/2" 12,000/2½" 10,000/3"	No
	3	Wlsn	Truck	2	12,000	15,000/2" 12,000/2½" 10,000/3"	No
	5	Frnks	Truck	2	14,000	15,000/2" 12,000/2½" 10,000/3"	No
	7	Frnks	Truck	2	14,000	15,000/2" 12,000/2½" 10,000/3"	No
Devine							
Douglas V Downing Well Serv	1	Border Foundry	Truck	2	4,500	4,000/2" 3,500/2½" 2,500/3"	No
	2	Wlsn Spr	Truck	2	7,000	7,000/2" 6,500/2½" 5,500/3"	Yes
	3	Wlsn Spr	Truck	2	7,000	7,000/2" 6,500/2½" 5,500/3"	Yes
	4	Wlsn Spr	Truck	2	7,000	7,000/2" 6,500/2½" 5,500/3"	Yes
	6	Wlsn Sr	Truck	2	6,000	5,000/2" 4,500/2½" 3,500/3"	Yes
Forsan							
Forsan Oil Well Serv	11	Frnks 33	Truck	1	—	3,500/2½"	Yes
	33	Crdwll 856	Truck	1	—	3,500/2½"	Yes
	44	Frnks 44TM	Truck	1	—	6,500/2½"	Yes
	658	Frnks 658	Trailer-Truck	1	13,000	13,000/2½"	Yes
	856	Wlsn Spr	Truck	2	11,000	10,000/2½"	Yes
Freer							
Douglas V Downing Well Serv	5	Frnks	Truck	2	4,500	4,000/2" 3,500/2½" 2,500/3"	No
Steitle Well Serv	1	Wlsn Mogul	Trailer	2	12,000	16,000/2½"	Yes
Goldsmith							
Goldsmith Well Serv Inc	1	Wlsn Mogul	Truck	2	15,000	10,000/2½"	No
	2	Wlsn 38	Truck	2	11,600	8,000/2½"	No
Goose Creek							
Rocket Well Serv	2	Wlsn Spr	Truck	1	—	9,500/2"	Yes
Grand Falls							
B H B Superior Well Serv Inc	4	Cooper TR38-38	Truck	2	9,000	8,000/2" 7,000/2½" 6,000/3"	Yes
Nichols & Freeman Well Serv	4	Wlsn Sr	Truck	2	4,500	5,000/2" 4,000/2½" 2,500/3"	No
	6	Wlsn Sr	Truck	2	4,500	4,000/2" 3,500/2½" 2,500/3"	No
	14	Wlsn Sr	Truck	2	5,000	5,000/2" 4,000/2½" 3,300/3"	No
	15	Wlsn Spr	Truck	1	—	8,000/2" 5,000/2½" 4,000/3"	No
	72	Wlsn Spr 38	Truck	2	11,000	10,000/2" 10,000/2½" 7,000/3"	No
Hamlin							
J W Frazier	2	—	Truck	2	8,000	7,500/2" 6,500/2½"	Yes
Hamlin Well Serv	1	Frnks 659	Truck	2	12,500	12,500/2" 10,000/2½"	Yes
	2	Frnks 65	Truck	2	10,000	10,000/2" 8,000/2½"	Yes
	3	Frnks 44	Truck	2	8,000	8,000/2" 6,000/2½"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Houston							
Joe Flower Well Serv Co	2	Wlsn Spr 38	Truck	1	—	11,000/2" 9,000/2½"	Yes
	3	Natl T	Truck	1	—	10,000/2" 8,000/2½"	Yes
	5	Frnks 65D	Truck	1	—	11,000/2" 9,000/2½"	Yes
French Drlg & Well Serv	1	Wlsn Spr 38	Truck	1	—	10,000/2" 9,000/2½" 6,500/3	No
Spur Well Serv Co	1	Frnks 65-TD	Truck	1	—	8,000/2½"	Yes
Kamay							
J W (Johnny) Birdwell Well Serv	2	Wlsn Master	Truck	2	5,500	5,500/2"	Yes
	3	Wichtex C-65	Truck	2	6,500	6,500/2"	Yes
	4	Wlkr-Nr	Truck	1	4,500	4,500/2"	No
	5	Wichtex C-65	Truck	2	6,500	6,500/2"	Yes
W R (John) Potter	—	Wlsn Master	Truck	2	5,500	6,700/2" 6,000/2½"	—
	—	Wlsn Spr	Truck	1	—	6,000/2" 5,500/2½"	
Kennedy							
Copeland & Fuller Well Serv	1	Wlsn Spr 38	Truck	2	8,000	8,500/2" 7,500/2½"	Yes
	2	Cooper A38	Truck	2	8,000	10,000/2" 8,500/2½"	Yes
Kermit							
M & B Well Serv	—	Frnks 658	Truck	2	14,000	—	—
	—	Frnks 658	Truck	2	14,000	—	—
Kilgore							
Bivin & Smoot Drlg Co	2	Wlsn Mogul	—	2	11,500	10,000/2" 10,000/2½" 7,500/3"	Yes
Carter-Jones Drlg Co Inc	1	Wlsn	Truck	1	7,000	5,000/2" 4,000/2½" 2,500/3"	No
	2	Wlsn	Truck	1	10,000	10,000/2" 8,000/2½" 5,000/3"	Yes
	3	Frnks	Truck	2	13,000	13,000/2" 10,000/2½" 7,000/3"	Yes
Potter Bros	1	Wlsn Spr	Truck	1	—	7,500/2" 6,500/2½" 5,500/3"	Yes
	2	Crdwll	Truck	1	4,000	7,500/2" 6,500/2½" 5,500/3"	Yes
	4	Wlsn Spr	Truck	1	—	5,000/2" 4,500/2½" 4,000/3"	No
Liberty							
Texas Workover & Oilwell Serv Co	3	Wlsn Spr	Truck	1	—	10,000/2" 8,000/2½"	No
	4	Wlsn Spr	Truck	1	10,000	—	No
	5	Wlsn Spr	Truck	1	10,000	—	No
Longview							
Texas Swabbing Co	1	Wlsn Spr	Truck	1	—	8,000/2" 7,500/2½"	Yes
	2	Wlsn Spr	Truck	1	—	8,000/2" 7,500/2½"	Yes
	3	Wlsn Spr	Truck	1	—	8,000/2" 7,500/2½"	Yes
	4	Wlsn Spr	Truck	1	—	8,000/2" 7,500/2½"	Yes
	5	Frnks	Truck	1	10,000	—	No
Luling							
Cleaveland Well Serv	1	Frnks 33	Truck	1	—	5,000/2" 3,300/2½" 2,600/3"	No
	2	Crdwll AH	Truck	2	5,000	5,000/2" 4,000/2½" 3,000/3"	Yes
McCamey							
Bradshaw's Oil Well Serv	—	Wlsn Spr	Truck	1	—	9,000/2" 6,000/2½" 5,000/3"	No
	—	Wlsn Sr	Truck	2	5,000	5,000/2" 4,000/2½" 3,000/3"	No

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Midland							
Penick Bros Casing Pulling Co	1	Wisn Spr	Truck	1	—	10,000/2" 10,000/2½" 10,000/3"	No
Pool Well Serv Co	15	Wisn Spr 38	Trailer	2	12,000	14,000/2½"	No
	17	Wisn Mogul 42	Trailer	2	14,000	14,000/2½"	No
	22	Wisn Mogul 42	Trailer	2	14,000	14,000/2½"	No
	27	WisnMogul 42	Trailer	2	14,000	14,000/2½"	Yes
Williamson Well Serv Inc	27	Frnks 658	Truck	2	13,500	13,500/2½"	No
	28	Frnks 658	Truck	2	13,500	13,500/2½"	No
	30	Frnks 658	Truck	2	13,500	13,500/2½"	No
	31	Frnks 658	Truck	2	13,500	13,500/2½"	No
New London							
Maxwell Well Serv Co	1	Wisn Spr	Truck	1	—	10,000/2" 8,500/2½" 6,500/3"	Yes
	2	Wisn Spr	Truck	1	—	10,000/2" 8,500/2½" 6,500/3"	Yes
	3	Wisn Spr	Truck	1	—	10,000/2" 8,500/2½" 6,500/3"	Yes
	4	Wisn Spr	Skid	1	4,500	—	—
	5	Wisn Spr	Skid	1	9,500	—	—
Miller & Co	1	Wisn Spr	Truck	1	—	5,000/2½"	No
	2	Wisn Spr	Truck	1	—	5,000/2½"	No
	3	Wisn Spr	Truck	1	6,500	5,000/2½"	No
	6	Wisn Spr	Truck	1	—	5,000/2½"	No
	8	Wisn Mogul	Truck	1	10,000	10,000/2½"	No
	9	MIW	Trailer	1	12,500	—	—
	10	Cooper	—	1	—	—	Yes
	12	Wisn Sr	Truck	1	6,500	3,500/2½"	—
Nocona							
R & R Well Serv Co	2	Wichtex	Truck	2	3,000	—	No
	4	Wichtex	Truck	2	3,000	—	No
Ross Constr & Well Serv	2	Wichtex	Truck	2	8,000	7,000/2" 5,400/2½"	No
	8	Crdwll	Truck	2	12,000	8,000/2" 7,000/2½"	Yes
Odessa							
Devonian Well Serv	6	Frnks 658	Truck	6	14,000	15,000/2" 14,000/2½" 11,000/3"	Yes
E & O Well Serv Co Inc	1	Crdwll S	Truck	1	13,500	—	No
J R Todd Co Inc	1	Frnks 658DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
	2	Frnks 658DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
	3	Frnks 658DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
	6	Crdwll K-200	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	Yes
Williamson Well Serv Inc	3	Frnks 658	Truck	2	13,500	13,500/2½"	No
	7	Frnks 658	Truck	2	13,500	13,500/2½"	No
	11	Frnks 658	Truck	2	13,500	13,500/2½"	No
	13	Frnks 658	Truck	2	13,500	13,500/2½"	No
	17	Frnks 658	Truck	2	13,500	13,500/2½"	No
	23	Frnks 658	Truck	2	13,500	13,500/2½"	No
	24	Frnks 658	Truck	2	13,500	13,500/2½"	No
	32	Frnks 658	Truck	2	13,500	13,500/2½"	No
	34	Frnks 658	Truck	2	13,500	13,500/2½"	No
	36	Frnks 658	Truck	2	13,500	13,500/2½"	No
Perryton							
Pool Well Serv Co	4	Wisn Spr	Truck	1	10,000	—	No
	16	Wisn Spr 38	Truck	2	12,000	10,000/2½"	No
	26	Wisn Spr	Truck	2	6,500	5,000"2½"	No
Pettus							
Carter Well Serv	1	Wisn Spr	Truck	2	9,500	9,500/2" 8,000/2½" 6,500/3"	Yes
	2	Wisn Spr	Truck	2	9,500	9,500/2" 8,000/2½" 6,500/3"	Yes
	3	Wisn Spr	Truck	2	9,500	9,500/2" 8,000/2½" 6,500/3"	Yes
Plains							
B H B Superior Well Serv Inc	1	Cooper A142-42	Truck	2	13,000	14,000/2" 12,500/2½" 11,000/3"	Yes
Pleasanton							
Keeney Well Serv Co	1	Crdwll	Truck	2	6,000	8,100/2" 6,000/2½" 4,000/3"	Yes
	2	Wisn Jr	Truck	2	7,000	6,000/2" 4,000/2½" 3,000/3"	Yes
Royalty							
Locke Well Serv	1	Wisn Spr	Truck	2	8,000	8,000/2" 8,000/2½" 8,000/3"	Yes
	2	Crdwll K	Truck	1	—	10,000/2" 7,000/2½" 5,000/3"	No
	3	Wisn Spr	Truck	2	10,000	10,000/2" 7,000/2½" 5,000/3"	Yes
Varner Oil Well Serv	1	Wikr-Nr P-25	Truck	2	6,000	6,000/2" 5,000/2½" 3,000/3"	No
	2	Wisn	Truck	2	—	3,000/2" 2,500/2½"	No
	3	Wisn	Truck	2	4,000	5,000/2" 4,000/2½" 3,000/3"	No
San Angelo							
Pool Well Serv Co	4	Wisn Spr	Truck	1	10,000	—	No
	16	Wisn Spr 38	Truck	2	12,000	10,000/2½"	No
	26	Wisn Spr	Truck	2	6,500	5,000/2½"	No
Seminole							
Hoffman Oil Well Serv Co	1	Wisn Spr 38	Truck	2	—	8,000/2½"	Yes
	2	Wisn Mogul	Truck	2	—	10,000/2½"	Yes
	3	Frnks 658	Truck	2	13,000	13,000/2½" 11,000/3"	Yes
	4	Frnks 658	Truck	2	13,000	13,000/2½" 11,000/3"	Yes
	5	Frnks 658	Truck	2	13,000	13,000/2½" 11,000/3"	Yes
	6	Frnks 658	Truck	2	13,000	13,000/2½" 11,000/3"	Yes
Seymour							
Bill Atchley	1	Wisn Jr	Truck	2	7,000	6,000/2" 4,000/2½" 3,000/3"	No
	2	Wisn Jr	Truck	2	7,000	6,000/2" 4,000/2½" 3,000/3"	No
Snyder							
Cactus Well Serv Co	1	Wisn Spr	Truck	1	10,000	—	No
	3	Wisn Spr 38	Truck	2	10,000	12,000/2" 10,000/2½" 8,000/3"	Yes
	7	Frnks 658DTM	Truck	2	12,500	14,000/2" 12,000/2½" 10,000/3"	Yes
Universal Oilwell Serv Inc	136	Frnks 65 DTM2	Truck	2	11,000	10,000/2" 8,000/2½" 6,000/3"	Yes
	146	Frnks 658	Truck	2	12,500	15,000/2" 12,000/2½" 10,000"3"	Yes
	182	Frnks 658/65	Truck	2	11,000	15,000/2" 12,000/2½" 10,000/3"	Yes
	204	Frnks 658/65	Truck	2	11,000	15,000/2" 12,000/2½" 10,000/3"	Yes
	218	Frnks 658/65	Truck	2	11,000	15,000/2" 12,000/2½" 10,000/3"	Yes
Sulphur Bluff							
Dood Emerson Well Serv & Gen Contg	1	Cooper E-60	Truck	1	5,000	10,000/2" 7,500/2½"	Yes
Sulphur Springs							
Dood Emerson Well Serv & Gen Contg	2	Wisn Spr	Truck	1	5,000	10,000/2" 7,500/2½"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Sweetwater							
J W Frazier	1	—	Truck	2	8,000	7,500/2" 6,500/2½"	Yes
	3	—	Truck	2	8,000	7,500/2" 6,500/2½"	Yes
	4	—	Truck	2	11,000	10,000/2" 9,000/2½"	Yes
Pool Well Serv Co	3	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	7	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
Victoria							
Slater Well Serv	1	Border Foundry	Truck	2	8,000	3,000/2" 2,000/2½"	No
Spears Well Serv Inc	1	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	2	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	3	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	4	Wlsn Spr	Truck	1	8,000	—	—
	5	Skytop Wltrwt	Truck	2	8,000	10,000/2" 8,000/2½"	Yes
	6	Skytop Wltrwt	Truck	2	8,000	10,000/2" 8,000/2½"	Yes
Well Serv Inc	1	Frnks TM65	Truck	1	—	8,500/2" 6,500/2½"	Yes
	2	Frnks TM65	Truck	1	—	8,500/2" 6,500/2½"	Yes
	3	Frnks TM65	Truck	1	—	8,500/2" 6,500/2½	Yes
Waskom							
James R Brown Well Serv	1	Wlsn Spr	Truck	1	10,000	—	No
	2	Wlsn Spr	Truck	1	—	12,000/2" 11,500/2½" 6,000/3"	Yes
	3	Wlsn Spr 38	Truck	1	—	13,000/2" 13,000/2½" 8,000/3"	Yes
Wichita Falls							
Deep Well Serv Co Inc	1	Wichtex C-65	Truck	2	6,200	6,500/2" 5,500/2½	No
McAlister Well Serv	7	Wlsn Spr	Truck	2	7,500	7,500/2" 6,500/2½"	No
	10	Wlsn Spr	Truck	2	7,500	7,500/2" 6,500/2½"	No
	20	Wlsn Spr	Truck	2	7,500	7,500/2" 6,500/2½"	No
	42	Wichtex	Truck	2	5,000	5,000/2" 3,600/2½"	No
	45	Wichtex	Truck	1	—	5,000/2" 3,600/2½"	No
Wickett							
White Well Serv	1	Crdwll K-200	Truck	1	12,000	10,000/2" 9,000/2½"	No
	2	Crdwll K-200	Truck	1	12,000	10,000/2" 9,000/2½"	No
	3	Crdwll K-200	Truck	1	12,000	10,000/2" 9,000/2½"	No
	4	Crdwll K200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	5	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	6	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	7	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	8	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	9	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	10	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	11	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	12	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
	13	Crdwll K-200	Truck	2	12,000	10,000/2" 9,000/2½"	No
Winnsboro							
Winnsboro Well Serv Co	F-1	Frnks Rocket	Truck	2	6,500	8,500/2" 7,200/2½"	Yes
	F-2	Frnks Rocket	Truck	2	6,500	8,500/2" 7,200/2½"	Yes
	F-6	Frnks 44	Truck	1	—	6,500/2" 5,000/2½"	Yes
	W-4	Wlsn Spr	Truck	1	8,500	—	—
	F-5	Frnks Spr	Truck	1	—	8,500/2" 7,200/2½"	Yes
Windthorst							
Bedford Thompson	2	Wichtex C-65	Truck	2	6,500	6,500/2"	—
Wink							
Permian Well Serv Inc	2	Wlsn Gnt	Truck	1	—	12,000/2" 10,000/2½" 8,000/3"	No
	3	Wlsn Spr	Truck	2	10,000	10,000/2" 8,500/2½" 6,500/3"	No
	6	Wlsn Spr	Truck	2	10,000	10,000/2" 8,500/2½" 6,500/3"	No
Winters							
Arrow Well Serv	1	Wichtex C-65	Truck	2	8,000	7,000/2" 5,500/2½"	No
	2	Wlsn Spr	Truck	2	9,000	10,000/2" 7,000/2½"	Yes
	3	Wlsn Spr	Truck	2	9,000	10,000/2" 7,000/2½"	Yes
	4	Wlsn Spr	Truck	1	10,000	—	No
Pool Well Serv Co	2	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	8	Wlsn Sr	Truck	2	6,500	5,000/2½"	No
	9	Wlsn Sr	Truck	2	6,500	5,000/2½"	No
	23	Wlsn Spr	Truck	1	10,000	—	No
	28	Wlsn Spr 38	Truck	2	12,000	10,000/2½"	No
WYOMING							
Cody							
Wyoming Well Serv Inc	24	Frnks 65/44	Truck	2	10,000	10,000/2" 8,000/2½" 6,000/3"	Yes
	30	Crdwll KS	Truck	1	8,000	9,000/2" 7,500/2½" 5,000/3"	Yes
Gass Creek							
Wyoming Well Serv Inc	23	Ideco 50-60	Truck	1	8,000	7,000/2" 6,000/2½" 4,000/3"	Yes
	25	Crdwll	Truck	1	8,000	3,500/2" 3,000/2½" 2,500/3"	Yes
	28	Crdwll HS	Truck	1	8,000	5,000/2" 4,000/2½" 3,000/3"	Yes
Linch							
Wyoming Well Serv Inc	22	Crdwll KS	Truck	1	9,000	8,000/2" 7,000/2½" 6,000/3"	Yes
	29	White L W	Truck	1	10,000	—	No

U. S. Cable Tool Servicing Rigs

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	No. of Drums	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
ARIZONA							
Mohave County							
Aldridge & Stroud Inc	6	btne	145	2	6000	6000	Wichita 61
CALIFORNIA							
Huntington Beach County							
Miller's Well Serv Co	2	prop	—	2	4500	5000	Allis Chmrs
COLORADO							
Sterling							
Signal Oilfield Serv Inc	4	dsl	125	2	—	7500	Crdwll RL
	5	dsl	125	2	—	7500	Crdwll RL
	11	gas	125	2	—	7500	Crdwll RL
ILLINOIS							
Lawrence County							
Payne Bros Drlg Co	1	dsl	150	3	3000	4000	B Erie 36-L
	2	dsl	150	3	3000	4000	B Erie 36-L
Wabash County							
Payne Bros Drlg Co	3	dsl	150	3	3000	4000	B Erie 36-L

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	No. of Drums	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
KANSAS							
Ellis County							
K Smith Cable Tools	1	gas-prop	145	2	3000	5000	Wlkr-Nr
Great Bend							
Signal Oilfield Serv Inc	1	dsl	125	2	—	7500	Crdwll RL
	7	gas	125	3	—	5000	Wlkr-Nr
	9	dsl	125	2	—	7500	Crdwll RL
Labette County							
Veeder Sup & Dev Co	BE 2	dsl	120	3	3500	4500	B Erie
NEW MEXICO							
Farmington							
Signal Oilfield Serv Inc	12	gas	125	2	—	7500	Crdwll RL
	13	gas	125	2	—	7500	Crdwll RL
Jal							
Art West Drlg Co	3	LPG	145	2	—	5500	Crdwll RL
	7	LPG	145	2	—	8000	Crdwll RL
OKLAHOMA							
Cushing							
Skinner & McDougal Drlg Co	3	gaso-btne	145	2	4000	5500	Crdwll
Elmore City							
Nelson Well Serv Co	3	gas-btne	185	3	—	12,000	Crdwll RL
Guymon							
Bice Drlg Co	1	dsl	185	2	3000	4500	Wichtex E90
	2	btne	210	4	7000	10,000	B Erie
Healdton							
Nelson Well Serv Co	2	gas-btne	145	3	—	10,000	Crdwll RL
Madill							
Nelson Well Serv Co	1	gas-btne	145	3	—	10,000	Crdwll RL
Okemah							
Skinner & McDougal Drlg Co	1	gaso-btne	145	2	4000	6500	Crdwll
	2	gaso-btne	145	3	4000	5500	Wlkr-Nr
Okmulgee County							
Smallwood & Sons	2	btne	—	3	3500	5600	B Erie 36-L
Pawhuska							
Kent Well Serv Co	2	LPG	80	3	3000	3600	Cooper
Pike City							
Line Oil Well Serv Co	1	gas-gaso-LPG	245	2	7500	10,000	Crdwll RL
	5	gas-gaso-LPG	245	3	7500	10,000	Crdwll RL
	6	gas-gaso-LPG	140	2	4500	5000	Crdwll K
Ponca City							
Ponca Drlg Inc	469	LPG	160	3	3500	4500	Wlkr-Nr E-36
Sapulpa							
Kent Well Serv Co	—	LPG	78	3	2600	3400	B Erie 28-L
	—	LPG	65	3	2200	2500	B Erie 60-L
Seminole							
Mills Drlg Co	6	gas-LPG	145	2	—	7500	Crdwll RL
	7	gas-LPG	145	3	—	7500	Crdwll RL
	8	gas-LPG	145	3	—	4500	Wlkr-Nr S-43
Shidler							
Signal Oilfield Serv Inc	3	gas	125	2	—	7500	Crdwll RL
	8	gas	125	3	—	5000	Wlkr-Nr
Velma County							
Atlas Well Serv	2	gas-LPG	145	3	—	7000	Crdwll RL
	3	gas-LPG	145	3	—	7000	Crdwll RL
	5	gas-LPG	145	3	6000	6000	Wlkr-Nr C-34
Woodward County							
Atlas Well Serv	4	gas-LPG	185	3	—	8500	Crdwll RL
TEXAS							
Abilene							
Cook's Well Serv Inc	—	btne	145	3	5000	7000	Wlkr-Nr
	—	btne	70	3	3000	3500	B Erie 28
Archer County							
Louis Pitcock Drlg Co	21	gas-btne	125	2	5000	8000	Wichtex 46
Electra							
Lloyd Jones Drlg Co	1	gas-gaso-LPG	130	3	2000	4000	Wlkr-Nr C-32
Holiday							
Baggett Drlg Co	2	LPG	175	2	—	7000	Wlkr-Nr 27
	3	LPG	200	3	7000	8000	Wlkr-Nr 34
	4	LPG	175	2	—	7000	Wlkr-Nr 27
Iraan							
Aldridge & Stroud Inc	4	btne	135	2	3000	4000	Ft Wrth D
	9	btne	225	2	6000	6000	Ft Wrth J
Kermit							
Art West Drlg Co	10	dsl	125	2	—	8000	Crdwll RL
Maverick County							
Errol Elkins Drlg Co	2	LPG	150	3	5000	6500	B Erie 36
	2	LPG	150	3	5000	6500	B Erie 36-L
McCamey							
C N Adkisson Jr	1	LPG	100	3	2500	3000	B Erie 28-L
Aldridge & Stroud Inc	8	btne	145	2	6000	6000	Wichita 61
Monahans							
Aldridge & Stroud Inc	1	gas	140	2	4000	5000	B Erie 36-L
	2	gas	140	2	4000	5000	B Erie 36-L
	5	gas	145	2	—	8500	Crdwll RL
	7	gas	145	2	—	8500	Crdwll RL
Odessa							
Art West Drlg Co	5	LPG	185	3	—	8500	Crdwll RL
	9	LPG	185	2	—	9000	Wisn Gnt
Pampa							
Baggett Drlg Co	1	LPG	200	3	7000	8000	Wlkr-Nr 37
Reeves County							
Aldridge & Stroud Inc	10	btne	145	3	2000	2500	B Erie 60-L
Ward County							
Aldridge & Stroud Inc	11	btne	145	2	4500	4500	Wichita 55
Wichita Falls							
Deep Well Serv Co Inc	2	LPG	110	2	—	6500	Wichtex C-65
McAlister Well Serv	32	LPG	185	3	—	7000	Wlkr-Nr C-34
Wickett							
Art West Drlg Co	6	gas	145	2	—	8000	Crdwll RL
	8	gas	145	2	—	8000	Crdwll RL
Windthorst							
Bedford Thompson	1	gaso	140	2	—	6500	—
WYOMING							
Converse County							
Prairie Drlg Co	2	gas	190	3	—	10,000	Crdwll RS
Natrona County							
Morrison Drlg Co Inc(Wyo)	1	btne	145	2	4500	6000	Crdwll
	2	btne	185	2	5500	8000	Crdwll
	3	btne	185	2	5500	8000	Crdwll

U. S. Rotary Workover Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Workover Depth, Ft
ARKANSAS						
Norphlet						
M Cheairs Oil Well Serv	1	gaso	90	Wisn Spr	90	5,000
CALIFORNIA						
Bakersfield						
General Prod Serv Inc	10	dsl	300	Hopper GTA	300	7,500/2⅛"
	12	dsl	300	Hopper M	380	12,000/2⅛"
Oil Well Serv Co	1-A	dsl	500	Ideco 40	300	13,000
	2-A	dsl	400	Ideco 40	300	13,000
	11	LPG	400	Ideco 30	280	8,000
	15	LPG	400	Ideco 30	300	10,000
Kernan						
Oil Well Serv Co	1	dsl	300	Ideco 30	300	8,000
	4-A	dsl	300	Ideco 30	300	8,000
	57	dsl	300	Ideco 35 Dr-In	300	12,000
Long Beach						
Blackwell & Sunde Co	3	btne	350	Ideco H-30-AD	250	6,000
	5	btne	350	Ideco TJ-440	250	6,000
	6	btne	350	Crdwll RL-319	152	4,500
Oil Well Serv Co	9	LPG	400	Ideco 30	300	10,000
Ventura						
Terminal Drlg & Prod Co	17	dsl	500	Wisn Mogul	350	12,000
	18	dsl	500	Ideco H-525D	600	16,000
Wheeler Ridge						
Drlg & Prod Co	1	dsl	325	Crdwll Tririg	420	12,500
Wilmington						
Terminal Drlg & Prod Co	1	gas	620	Natl 50	450	12,000
	12	gas-LPG	320	Ideco H-30D	190	9,000
	14	gas-LPG	140	Ideco H-25D	125	3,500
KANSAS						
McPherson County						
Veeder Supply & Dev Co	E	dsl	270	Frnks 658	270	8,000
LOUISIANA						
Colquitt						
Johnson Drlg & Serv Co	2	dsl	500	Beth Twister	300	12,500
Eunice						
T & H Well Serv Co	1	gas-gaso-btne	225	Wisn Spr 38	180	18,000
Lisbon						
Johnson Drlg & Serv Co	1	dsl	200	Beth Breeze	200	10,000
Plaquemines Parish						
Clinch Drlg Co	Bge 1	ds	—	Emsco GA-350	426	12,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Workover Depth, Ft
Springhill						
J C Williams Well Serv Co	9	dsl	220	Wlsn Mogul	220	1,200
Terrebonne Parish						
Cron & Gracey Corp	3	dsl	—	TIW CT-5	520	16,000
Vermilion Parish						
Wm Hawkins Drlg Co	2	gas-btne	300	Unit U-15	485	16,000
MISSISSIPPI						
Bolton						
Graham Bros Oil Well Serv	6	dsl	180	Crdwll K-201	190	13,500
MONTANA						
Glendive						
Signal Oilfield Serv Inc	6	LPG	150	Frnks 65/44	200	8,000
	10	dsl	250	Frnks 658/65	250	12,000
NEVADA						
Churchill County						
Barry Well Drlg Co	2	dsl	200	—	—	8,000
OKLAHOMA						
Ardmore						
Quad Drlg Co	1	gaso-btne	1000	Frnks Gnt Clipper	275	15,000
	2	btne	150	Crdwll KL	125	6,500
Beaver County						
Beckman Inc	19	—	180	MIW P-42	175	10,000
Beckham County						
Beckman Inc	17	gas	150	MIW P-42	200	10,000
Harper County						
Beckman Inc	3	gas	150	MIW P-42	200	10,000
	5	—	180	MIW P-42	175	10,000
Healdton						
N & L Drlg Co	1	gas-btne	325	Brwstr N-4	200	12,000
Noble County						
Chambless-Rosen Drlg Co	1	gas-btne	225	Crdwll RL	200	8,000
Okmulgee						
Twinoak Drlg Co	1	dsl	190	Frnks 3000	190	3,500
Osage County						
Glenn Gillespie & Sons	7	dsl	300	Frnks 658 TRD	225	8,000
Payne County						
Glenn Gillespie & Sons	1	gas	360	Unit U-34	225	8,000
Velma County						
Atlas Well Serv	1	gas-LPG	325	Crdwll RL 185	185	12,000
TEXAS						
Alice						
Mohawk Oil Well Serv	2	dsl	125	Wlsn Spr	125	7,500
	3	dsl	125	Wlsn Spr	125	7,500
	4	dsl	125	Wlsn Spr	125	7,500
W M & W Well Serv Co	9	dsl	300	Wlsn Spr	150	4,000
Andrews County						
Denver Drlg Corp	4	gas	440	Natl 50	440	15,000
Aransas County						
Camden Drlg Co	Bge 2	dsl	600	Natl T-32	300	10,000
Atascosa County						
Sutton Prod Co	5	gas-gaso	—	Wlsn	125	3,500
	8	gas-gaso	—	Wlsn	125	5,000
Cherokee County						
Gibson Drlg Co	2	gas-btne	225	Wlsn Mogul 42	145	8,000
Chico						
Carter-Jones Drlg Co Inc	7	btne	370	Wlsn Gnt	225	12,000
Cochran County						
Price-Sitton Drlg Co	1	btne	270	Wlsn Gnt	270	8,000
Colorado City						
W & C Well-Serv	5	dsl-LPG	150	Wlsn Spr 38	212	10,000
	6	dsl-LPG	150	Wlsn Spr 38	212	10,000
Colorado County						
Chet Whaley Well Serv Co	1	gas-gaso-btne	225	Wlsn Gnt	225	8,000
Conroe						
Spur Well Serv Co	2	gas-gaso	100	Frnks 65-TD	180	8,000
Corpus Christi						
Carpenter Bros Well Serv						
Carpenter Bros Swabbing Inc	1	gas-gaso btne	145	Cooper A45-36	145	10,000
Crosby County						
Smith & Breyer	4	gas	530	Frnks	530	15,000
Devine						
Douglas V Downing Well Serv	7	LPG	250	Wlsn Spr	185	8,500
Dimmit County						
Sutton Prod Co	9	—	—	—	—	4,000
Ector County						
Beckman Inc	1	gas	185	Unit U-15	350	6,000
	2	gas	185	Beth S-50	185	3,500
Denver Drlg Corp	1	gas	370	Crdwll EC	370	10,000
Darrell W Smith Co	1	dsl	470	Crdwll D	470	15,000
Freer						
Steitle Well Serv	1	dsl	311	Wlsn Mogul	302	16,000
Garza County						
Smith & Breyer	2	gaso	—	Cooper	200	7,500
	3	btne-dsl	355	Spencer	355	9,000
Gray County						
Beckman Inc	12	gas	150	MIW P-42	175	10,000
Harris County						
Justrite Serv Co	1	gas	185	Frnks TD-65	185	4,000
Harrison County						
Gibson Drlg Co	3	gas-btne	300	Wlsn Gnt	275	9,000
Houston						
C B S Workover Co	1	gas-btne	250	Ideco H-30-D	200	12,000
	2	gas-btne	200	Crdwll K	150	8,000
	3	gas-btne	200	Ideco H-30-D	200	12,000
Joe Flower Well Serv Co	1	gas-btne	400	Natl T-20	300	13,000
French Drlg & Well Serv	2	gas-LPG	360	Wlsn Mogul	225	12,000
Spur Well Serv Co	1	gas-gaso	100	Frnks 65-TD	180	8,000
	3	gas-LPG-dsl	250	Frnks 137	580	12,000
W L B Drlg Co	1	gas-gaso-btne	344	Brwstr N-35	187	10,000
Jackson County						
Mac Drlg Co	5	gas-gaso-btne	275	Beth S-45	450	15,000
Chet Whaley Well Serv Co	2	gas-gaso-btne	225	Wlsn Gnt	275	8,000
Kilgore						
Carter-Jones Drlg Co Inc	11	btne	370	Brwstr N-4	185	12,000
Liberty						
Texas Workover & Oilwell Serv Co	2	gas-LPG	475	Brwstr N-4	450	14,000
Lipscomb County						
Beckman Inc	18	gas	150	MIW P-42	200	10,000
Longview						
Texas Swabbing Co	1	LPG	—	Wlsn Spr	80	8,000
	2	LPG	—	Wlsn Spr	80	8,000
	3	LPG	—	Wlsn Spr	80	8,000
	4	LPG	—	Wlsn Spr	80	8,000
Midland County						
Beckman Inc	11	gas	300	Unit U-34	300	4,500
Nacogdoches County						
Gibson Drlg Co	4	gas-btne	226	Wlsn Mogul	225	7,500
Navarro County						
Stroube Drlg Co	—	btne	175	Mayhew	175	2,000
Overton						
Miller & Co	—	LPG	140	Cooper E-42	140	5,000
Sulphur Springs						
Dood Emerson Well Serv & Gen Contg	2	LPG	180	Wlsn Spr	145	4,500
Victoria						
Slater Well Serv	4	dsl-gaso	200	Ideco H-20AD	120	9,000
Victoria County						
Glenn Drlg Co	3	gas	145	Crdwll S	145	7,000
Waskom						
James R Brown Well Serv	3	LPG	75	Wlsn Spr 38	220	12,000
Wichita Falls						
McAlister Well Serv	16	LPG	80	Reverse Circ Rig	—	6,000
Wink						
Permian Well Serv Inc	1	LPG	200	Crdwll RL	290	12,000
Winnsboro						
Winnsboro Well Serv Co	F-1	btne	145	Frnks Rocket	178	7,200
	F-2	btne	145	Frnks Rocket	178	7,200
Winters						
Arrow Well Serv	2	LPG	150	Wlsn Spr	135	8,000
	3	LPG	150	Wlsn Spr	135	8,000
Wood County						
Gibson Drlg Co	1	gas-btne	275	Wlsn Mogul 42	265	8,000
WYOMING						
Cody						
Wyoming Well Serv Inc	24	gas	200	Frnks 5039	220	8,000

Some Casing Pulling Equipment

Contractor's Name	Rig No.	Description of Casing Pulling Equipment
KANSAS		
El Dorado		
Kent Well Serv Co	—	Hydraulic casing pulling rig—depth capacity: 5000 ft
TEXAS		
Kilgore		
Potter Bros	1	Wlsn Spr single drum servicing unit available for casing pulling jobs
	2	Crdwll single drum servicing unit available for casing pulling jobs

Contractor's Name	Rig No.	Description of Casing Pulling Equipment
Midland		
Penick Bros Casing Pulling Co	—	Two casing pulling rigs complete: Wisn Spr single-drum truck-mounted. Pulling capacity 15,000 lb on mast pole; 300,000 lb on jacks.
Snyder		
C E Knight & Co	—	3 truck-mounted units, range 3 pipe. Handle rods, tubing, mudding hc'e, spotting cement, circulating and shooting. 2 large rigs for pulling and plugging to 16,000 ft. A smaller unit for 8000 ft jobs. Hydraulic jacks.
ALBERTA PROVINCE, CANADA		
Edmonton		
General Well Serv Ltd	—	Complete subsurface abandonment and casing pulling and shooting. Fort Houston Iron Works jacks and hydraulic pump. Single pole mast, single drum, trailer-mounted unit.

Canadian Well Servicing Contractors

Alphabetical List

CANADA

Beta Well Serv Ltd 5930 96 St Edmonton Alberta Canada
Calgary Oil Field Serv Ltd 133 6th Ave SE Calgary Alberta Canada
Coralta Drlg Ltd Box 4104 Edmonton Alberta Canada
General Well Servs Ltd 10955 66th Ave Edmonton Alberta Canada
Kenyons Drlg & Serv Ltd 10439 82nd Ave Edmonton Alberta Canada
Redwell Serv Co Ltd 6530 100th St Edmonton Alberta Canada
Souris Serv Co Ltd 940 8th Ave West Calgary Alberta Canada
Virden Drlg Co Ltd Box 667 Virden Manitoba Canada

Canadian Contract Well Servicing or Pulling Units

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity: Swabbing	Estimated Capacity: Pulling	Can Unit Also Drill?
ALBERTA PROVINCE							
Drayton Valley							
Beta Well Serv Ltd	8	Crdwll K-201	Truck	2	—	10,000/2" 8,500/2½"	Yes
	10	Crdwll K-201	Truck	2	—	10,000/2" 8,500/2½"	Yes
Edmonton							
Beta Well Serv Ltd	6	Crdwll AH	Truck	2	—	6,000/2" 5,000/2½"	Yes
	7	Crdwll L-150	Trailer	2	—	12,000/2" 10,000/2½"	Yes
	9	Cooper W-26	Truck	2	5,000	3,500/2½"	Yes
Redwell Serv Co Ltd	6	Crdwll AH	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
	9	Frnks Clpr 65	Truck	2	9,000	13,000/2" 10,000/2½" 7,000/3"	Yes
Pembina							
Redwell Serv Co Ltd	1	Crdwll H	Truck	1	9,000	7,000/2" 5,000/2½" 3,500/3"	No
	3	Crdwll H	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
	5	Crdwll AL	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
	10	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/3"	Yes
Red Deer							
Redwell Serv Co Ltd	7	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/3"	Yes
	8	Frnks Clpr 65	Truck	2	9,000	13,000/2" 10,000/2½" 7,000/3"	Yes
	11	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/3"	Yes
Redwater							
Beta Well Serv Ltd	2	Crdwll H	Truck	1	—	5,000/2" 4,000/2½"	Yes
	3	Crdwll Mobilhst	Truck	2	—	5,000/2" 4,000/2½"	Yes
Stettler							
Redwater Serv Co Ltd	2	Crdwll H	Truck	1	9,000	7,000/2" 5,000/2½" 3,500/3"	No
Wetaskiwin							
Calgary Oil Field Serv Ltd	1	Wisn Spr 38	Truck	2	12,000	10,000/2½"	Yes
	3	Wisn Mogul 42	Truck	2	12,000	10,000/2½"	Yes
	4	Wisn Mogul 42	Truck	2	12,000	10,000/2½"	Yes
BRITISH COLUMBIA PROVINCE							
Ft. St. John							
Calgary Oil Field Serv Ltd	2	Wisn Spr 38	Truck	2	12,000	10,000/2½"	Yes
MANITOBA PROVINCE							
Virden							
Virden Drlg Co Ltd	4	Crdwll H	Truck	2	6,000	6,000/2" 5,500/2½" 5,000/3"	Yes
	7	Crdwll Q	Truck	1	3,000	3,000/2" 2,500/2½" 2,000/3"	Yes

Canadian Cable Tool Servicing Rigs

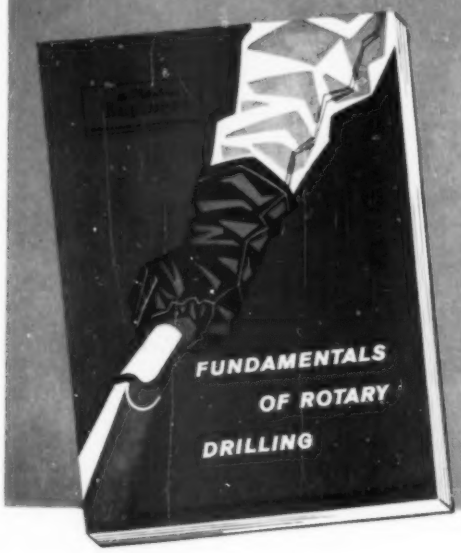
Contractor's Name	Rig No.	Type Power	HP of Driving Engine	No. of Drums	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
MANITOBA PROVINCE							
Virden							
Virden Drlg Co Ltd	2	dsl	150	3	6000	6000	B Erie 36-L
	8	gas	85	3	3000	3000	B Erie 28-L

Canadian Rotary Workover Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALBERTA PROVINCE						
Coronation						
Coralta Drlg Ltd	2	gas	180	Failing 1500	180	1,500
Edmonton						
Coralta Drlg Ltd	1	gas	180	Failing 1500	180	1,500
Kenyon's Drlg & Serv Ltd	11	dsl	—	Crdwll 151	350	10,000
Redwell Serv Co Ltd	12	dsl	260	Crdwll L	180	10,000
	13	dsl	260	Crdwll L-350	260	13,000
MANITOBA PROVINCE						
Virden						
Virden Drlg Co Ltd	4	dsl	170	Crdwll H	150	6,000
	7	gas	170	Crdwll Q	110	2,500
SASKATCHEWAN PROVINCE						
Estevan						
Kenyon's Drlg & Serv Ltd	12	dsl	—	Frnks Comet 658	250	9,000
Souris Serv Co Ltd	1	dsl	—	Crdwll AL	114	4,000/2⅛"
	2	dsl	—	Frnks Rocket	114	4,000/2⅛"
	3	gas	—	Crdwll AL	144	4,000/2⅛"

Foreign Well Servicing Equipment

VENEZUELA						
(Eastern)						
Perforaciones Delta C A (Caracas, Venezuela)	7	dsl	260	Ideco H-30-D	300	10,000



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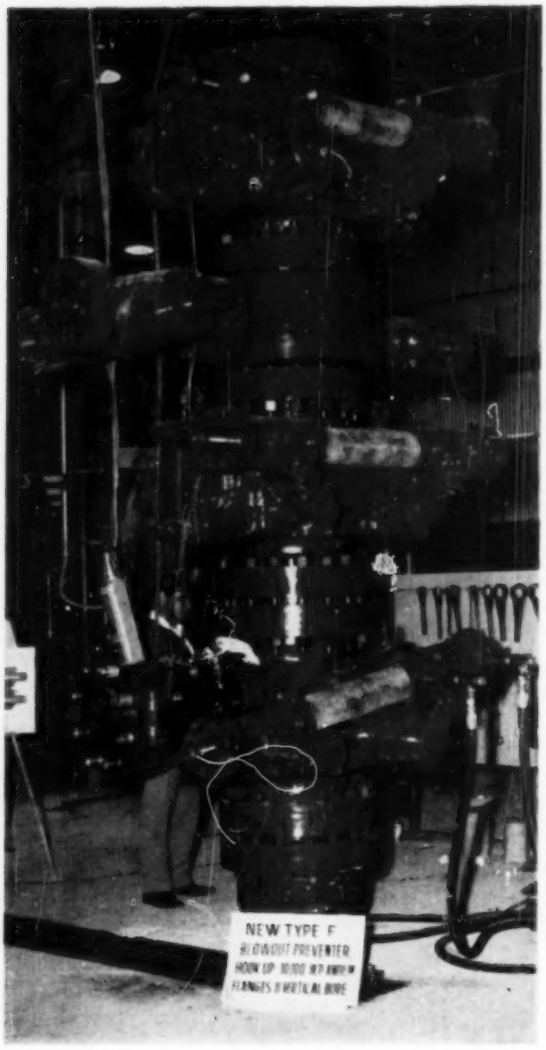

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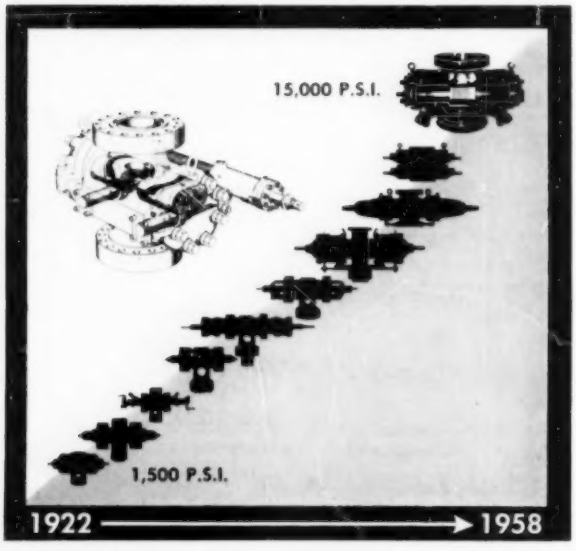

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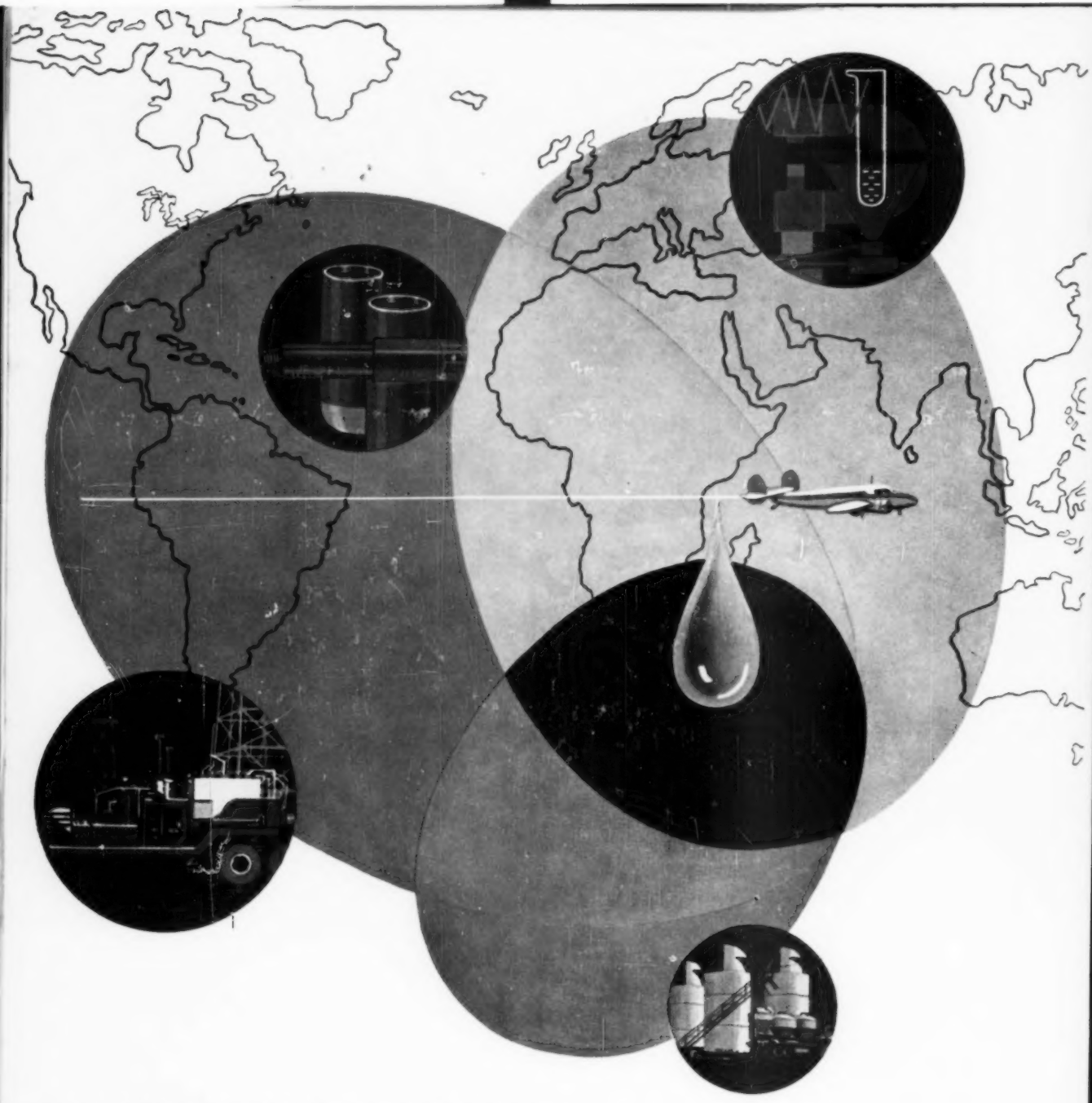

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